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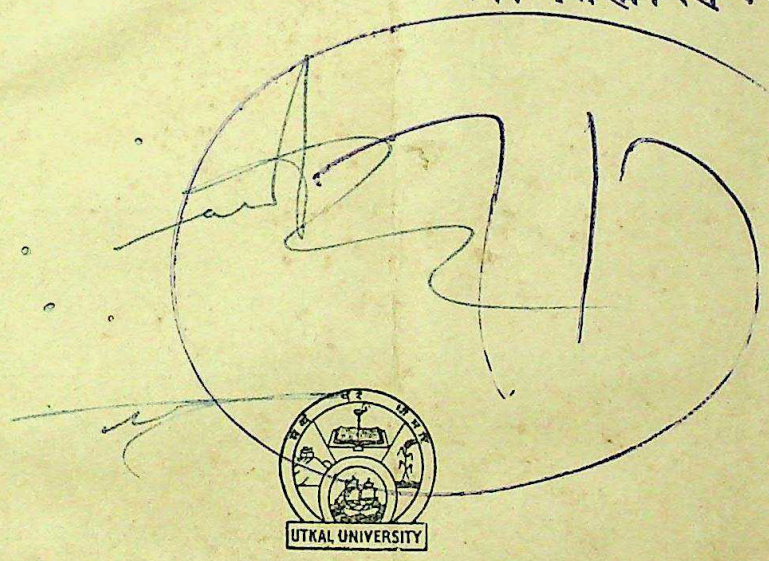

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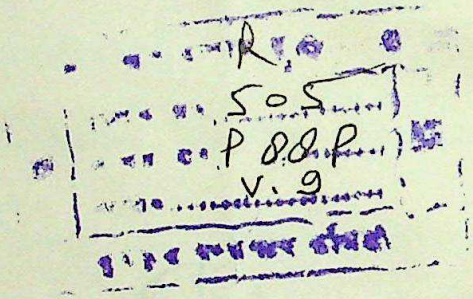

CONTENTS

Prakruti—Utkal University Journal—Science
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RELATIVE EFFICIENCY OF HERBICIDES ON CONTROL OF WEEDS IN UPLAND RICE

G. K. Patro and **B. C. Sahoo**

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ABSTRACT

TOK-E-25, Machete, Stam F-34 and Stam LV-10 were tried as post-emergence sprays at 2 dosage rates of 2 Kg and 3 Kg a.i./ha. They were compared against a pre-sowing spray of Na Salt of 2, 4-D@ 0/5 Kg a.i./ha and the cultural treatments of 2 hand weedings, weedfree control and unweeded control. Amongst all the treatments tried, weed-free control recorded the maximum and significant increased yields. Amongst the herbicides tried, TOK-E-25 was found to be most promising and controlled the weeds efficiently resulting in good crop growth and yield. TOK-E-25 when applied either at 2 Kg or 3 Kg a.i./ha was found to be significantly superior to all other herbicidal treatments, cultivator's practice of 2 hand weedings and unweeded control.

INTRODUCTION

Weeds cause severe crop losses in rice fields of Orissa. This is more particularly so in the uplands rather than in the medium and low lands. The conventional methods of employing human labour has been found to be tedious, time-consuming, and at the same time quite expensive. Added to that, shortage of labour during the peak periods of weeding causes considerable difficulty in attending to the mechanical operations in time. It was, therefore, thought necessary to find more efficient methods of weed control for obtaining good crop yields in rice.

REVIEW OF LITERATURE

Studies undertaken within the country and abroad have explored the possibilities of tackling the weed problems of rice more efficiently by the application of herbicides. Bharadwaj and Verma (1959) reported efficient weed control in rice fields by phenoxy herbicides like 2,4-D and M.C.P.A. They recommended a mild dose of 0·5 Kg a.i./ha as a post-emergence spray against control of weeds in rice. Chakravarty (1963), Vachani *et al.*, (1963) concluded that M.C.P.A. was the most efficient weedicide in controlling the weeds of rice crop. But Patro *et al.*, (1969) observed that

application of any of the phenoxy herbicides like 2,4-D or M.C.P.A. could not control the dominant monocot weed population that existed in the experimental field although these herbicides were quite effective against the broad leaved weeds present. Brandes (1962) and Mukhopadhyay (1964) suggested the use of Stam F-34 in rice fields for effective weed eradication.

Basing on the above information, propanil was tried with its two commercial formulations of Stam F-34 and Stam LV-10 and was compared with the newly introduced chemicals like Machete and TOK-E-25 and with the popular herbicide 2,4-D in the present investigation.

MATERIALS AND METHODS

The investigation was carried out at the Model Agronomic Centre, Bhubaneswar during the year 1972-73 (*Kharif*) with 12 treatments and 4 replications fitted in a randomised block design with the test crop of rice (variet : *Bala*). Stam F-34, Machete and TOK-E-25 were tried with 2 varying doses of 2 Kg and 3 Kg a.i/ha as post-emergence sprays. 2,4-D was however tried as a pre-sowing spray 7 days prior to sowing after final land preparation. These treatments were compared along with the conventional practice of 2 hand weedings undertaken at 3 and 6 weeks after sowing. A weedfree control and unweeded control was also kept to assess the effect of weed incidence on crop growth and yield of rice. Biometric observations relating to plant height, effective number of tillers were recorded on sample basis. Week population and dry weight of weeds were recorded at 2 different stages of crop growth from sampling units of 0·5 m × 0·5 m chosen at 3 places at random. The grain yield was recorded after final sun-drying on net plot size basis and indicated as Kg per hactare under table No. 2. The post-harvest observations with respect to length of panicle, 1,000 grain weight, number of fertile grains were recorded treatment-wise and are presented in Table No. 2.

RESULTS AND DISCUSSION

A. Weed Survey

14 different weeds were found in the unsprayed check plots (unweeded control) from the commencement of the crop till maturity. The detailed composition of weeds at the time of crop maturity presented in Table 1 revealed that the dominant weed population consisted of grasses and sedges. The percentage of grasses was 48·7 while the percentage of sedges was 26·8. The broad-leaved weeds constituted 24·5% of the total weed population. But then, they did not cause any serious hinderance for the crop growth, as they were quite tender.

Table 1

Type of weeds and their percentage composition at harvest in rice.

Type of weeds and their names	% Composition in the unweeded control plot
A. NARROW-LEAVED WEEDS	
(*a*) Grasses	
(1) *Digitaria sangunalis* (L.) Scop.	13·5
(2) *Eleusine indica* (L.) Gaertn.	12·2
(3) *Echinocloa colonum* (L.) Link.	10·2
(4) *Panicum miliare* (Vasey)	5·6
(5) *Eragrostis charris*	7·2
	48·7
(*b*) Sedges	
(1) *Cyperus rotundus* L.	8·5
(2) *Cyperus iria* L.	8·8
(3) *Cyperus articulus* L.	9·5
	26·8
B. BROAD-LEAVED WEEDS	
(1) *Solanum nigrum* L.	2·5
(2) *Acanthospermum hixpidum* DC	5·0
(3) *Amaranthus retroflex* L.	5·5
(4) *Celosia argentia* L.	4·5
(5) *Mimosa pudica* L.	5·0
(6) *Commelina benghalensis* L.	2·0
	24·5

Table 2

Herbicidal efficiency with respect to weed growth, crop growth and grain yield in rice

Sl. No.	Treatments	Weed growth before post-emergence spray (7 days after sowing)		After post-emergence spray (15 days after germination)		Crop growth					
		Weed count	Weed weight (Gms.)	Weed count	Weed weight (Gms.)	Effective number of tillers	Shoot length (cm)	Panicle length (cm)	Fertile grain per panicle	1000 grain weight (Gms.)	Grain yield (Kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
T_1	Stam F-34 @ 2 Kg a.i./ha	40	31·2	31	22·8	5·65	46·7	19·1	67·5	19·1	3114
T_2	Stam F-34 @ 3 Kg a.i./ha	39	31·0	26	21·4	5·72	47·0	20·4	69·3	19·5	3214
T_3	Machete @ 2 Kg a.i./ha	40	32·7	38	22·6	5·67	46·8	20·4	69·7	19·6	3285
T_4	Machete @ 3 Kg a.i./ha	41	33·4	34	23·5	5·60	46·6	19·9	68·6	19·2	3214
T_5	TOK-E-25 @ 2 Kg a.i./ha	35	32·7	27	22·5	5·92	49·3	20·1	70·2	19·9	3364
T_6	TOK-E-25 @ 3 Kg a.i./ha	36	30·7	21	21·2	6·253	51·7	20·9	70·6	20·2	3397
T_7	2, 4-D (Na.Salt) 0·5 Kg a.i./ha	19	17·3	20	18·2	5·92	47·7	20·1	68·1	19·5	3,114
T_8	Stam LV-10 @ 2 Kg a.i./ha	38	33·2	38	27·6	5·80	47·0	20·0	67·3	19·7	3121
T_9	Stam LV-10 @ 3 Kg a.i./ha	43	35·1	40	29·2	6·12	48·4	19·9	68·5	20·2	3825
T_{10}	2 weedings 3 and 6 weeks after sowing	34	33·5	34	24·8	6·25	49·5	21·0	70·8	20·7	3228
T_{11}	Weedfree control	21	20·3	14	11·9	6·70	53·8	22·8	72·5	22·7	3800
T_{12}	Unweeded control	37	32·4	78	68·8	4·25	37·9	16·8	61·2	17·6	1514
	S.E(m) ±	...	...	1·6	0·9	0·02	0·8	0·1	0·2	0·1	39·53
	C.D. at 5%	...	...	4·61	2·59	0·04	2·3	0·28	0·57	0·28	80·4

B. Weed Growth

The weed population and dry weight of weeds recorded 7 days after sowing (*i.e.* 15 days after pre-sowing spray of 2, 4-D) showed that there was significant reduction in the quantum of weed growth in the treatment as compared to all other treatments, with the exception of weed free check which was of course comparable.

This indicated the efficiency of the pre-sowing effects of 2, 4-D at the initial stages of crop growth. But towards the later stages of crop growth, it was observed that the grasses and sedges created considerable crop weed competition. But post-emergence application of TOK-E-25 on the other hand could efficiently control the grasses and sedges and also broad-leaved weeds most efficiently as compared to all other post-emergence herbicides tried. TOK-E-25 applied at 3 Kg. a.i/ha recorded the minimum weed population and dry weight of weeds (41·6% control on the basis of weed count and 30·9% control on the basis of weed weight). Next to TOK-E 25, Stam F-34 appeared to be promising. The performance of Machete and Stam-LV-10 were inferior to Stam F-34 application. Amongst the pure cultural treatments, minimum weed growth under two hand weedings and maximum weed growth under unweeded control.

Crop growth — Effective number of tillers and shoot height are important components of crop growth. A perusal of the data under Table 2 revealed that maximum number of effective tillers could be recorded under weed free control and this was subsequently followed by the post-emergence application of TOK-E-25 @ 3 Kg. a.i./ha and 2 hand weedings. It was further observed that all the three herbicides TOK-E-25 Stam F-34 and Stam LV-10 recorded higher number of effective tillers with their increaing doses. Minimum number of tillers were recorded with unweeded control. This variation with respect to the effective number of tillers can be explained for the differential competition of weeds with the crop. More or less same trend was noticeable with respect to shoot growth although the variations were not as pronounced as in the case of effective number of tillers.

C. Other Yield Attributes

(*i*) *Panicle length*—The length of panicle is an important yield attribute and the observations recorded in different treatments revealed that the maximum panicle length was obtained from the weed-free control treatment. This was found to be significantly superior over all others tried. This could obviously be possible for the ideal conditions received by the crop in drawing adequate nutrition from the soil without any interference from the

associated weeds. Next to the treatments of weed-free control, the two treatments of 2 hand weedings and the single post-emergence application of TOK-E-25 @ 3 Kg a.i./ha was found to be at par with respect to the length of panicles for efficiently controlling the major dominant weed population with equal efficiency and were found to be significantly superior to all other remaining treatments. Due to heavy weed competition, there was poor crop growth in unweeded control and this in turn resulted in significant reduction in the length of panicles in the rice crop.

(*ii*) *Number of fertile grains per panicle*—Depending on the availability of nutrients during the reproductive phase for better grain filling, there will be differential number of fertile grains per panicle. This was correctly observed under weed-free control and unweeded control. The weed-free control recorded the maximum number of fertile grains (72·5 per panicle) while the unweeded control recorded the minimum number of fertile grains per panicle (61·2 per panicle). This phenomenon occurred because the weedfree control did not receive any set back in its growth (both vegetative and reproductive) while unweeded control received tremendous interference in its growth from the beginning of the crop till maturity from extraneous agencies (weeds). The timely hand weedings in the cultivators' practice (2 hand weedings) and the promising efficiency of TOK-E-25 could knock down most of the associated weeds and recorded good growth of the crop both during its vegetative and reproductive phase and recorded good number of fertile grains per panicle, while the other herbicides did not come up to expectations due to inefficient control of weeds.

(*iii*) 1,000 *grain weight*—Weight of 1,000 grains recorded under table 2 revealed that keeping weedfree situations from the beginning of the crop till maturity under weed free control could produce plumpy grains and recorded a grain weight as high as 22·7 gm. It was found to be significantly superior to all other treatments. Next to the treatment, the treatment of 2 hand weedings was found to be the best. Amongst all other herbicidal treatments, it was observed that TOK-E-25 application was the best with respect to obtaining plumpy and good grains. Minimum 1,000 grain weight was obtained under unweeded control due to poor and ill-formed grains.

D. Grain Yield

Weed free control recorded maximum significant increased yield over all other treatments tried. It recorded a yield as high as 3,800 Kg/ha with the early maturing variety '*Bala*' (Table 2). This could obviously be possible for the elimination of crop-weed competition at all stages of

crop growth and which in turn resulted in good crop growth both vegetatively and reproductively.

Among the rest of the treatments TOK-E-25 was found to be the most promising with respect to its efficient weed control resulting in good crop growth as evidenced by higher number of tillers, shoot length, length of panicle, number of fertile grains per panicle and weight of 1,000 grains. The performance of Machete was moderate due to moderate control of weeds. The conventional practice of 2 hand weedings was found to be at par with Machete application. 2, 4-D hand weedings was found to be significantly inferior to TOK-E-25, Machete and the cultivators' practice. This may obviously be due to inefficient control of the grasses and sedges at later stages of crop growth. It was further observed that application of either Stam F-34 or Stam LV-10 with their higher doses (3 Kg. a.i./ha) were found to be significantly superior over their corresponding lower doses (2 Kg. a.i./ha). The significant reduction in unweeded control with respect to grain yield as compared to all other treatments can be attributed for the unchecked weed growth resulting in poor crop growth and poor formation of number of earheads and number of fertile grains per panicle.

Table 3

Comparative economics of the best herbicidal treatment (TOK-*E-25 with weed-free control*

	Gross income in Rs.	Cost of cultivation excluding interculture (Rs.)	Cost towards interculture (Rs.)	Total cost of cultivation (Rs.)	Net profit Rs./ha.
TOK-E-25 2 Kg	2287·52	833·75	214·00	1047·75	1239·77
TOK-E-25 3 Kg	2309·96	835·00	300·00	1135·00	1174·96
Weed-free control	2584·00	865·25	675·00	1540·25	1043·75

Cost was calculated at sale price of rice at Re. 0·68 per Kg. Labour charges per adult male at Rs. 2·75 per day and adult female Rs. 2·25 per day. Cost of herbicide per Kg. of commercial product of TOK-E-25 Rs. 21·50.

E. **Comparative Economics**

The comparative economics of the best herbicidal treatment of TOK-E-25 with that of weed free control showed that the cost of interculture was

as high as Rs. 675/- ha with weed free control treatment while a modest expenditure of Rs. 214/- (2 Kg dose) and Rs. 300/- (3 Kg dose) was incurred with TOK-E-25 application. The comparison of the net profits showed that weedfree control recorded a net profit of Rs. 1,043·75/- ha and TOK-E-25 recorded even higher net profits (Rs. 1,239·77) with 2 Kg. dose and 1,174·96 with 3 Kg. dose of TOK-E-25) per hactare.

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EFFECT OF HOST AND SOME OTHER FACTORS ON THE BIOLOGY OF *PERISIEROLA NEPHANTIDIS* MUES—A LARVAL PARASITE OF THE COCONUT CATERPILLAR, *NEPHANTIS SERINOPA* MEYR.

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ABSTRACT

Habits and biology of *Perisierola nephantidis* Mues, a larval parasite of the coconut caterpillar, *Nephant is serinopa* Meyr. was studied in the laboratory. The parasite could be reared on the larvae of *N. serinopa*, *Corcyra cephalonica* and *Nephopteryx eugraphella*. It took 12·6 days to complete its life cycle on *C. cephalonica* as compared to 11·8 days on *N. serinopa* . The fecundity of the female was more when the adult was fed with a mixture of sugar solution and egg crush of rice moth eggs and the rate of oviposition was minimum when only water was provided to the adult female. On an average, 102 eggs were laid by an individual female when reared at a relative humidity of 80%, but laid only 4.2 and 17 eggs at relative humidities of 50 and 95% respectively.

INTRODUCTION

Some exotic and indigenous parasites are being used successfully to control the black-headed caterpillar, *N. serinopa* on coconut. In the coconut belt of Orissa *Spoggosia* (*Stomatomyia*) *bezziana* and *Microbracon hebetor* are being utilised for the control of *N. serinopa*. A larval parasite, *Perisierola nephantidis* Mues. of the coconut black-headed caterpiller has been reported to be an effective enemy of the pest (Ramachandra Rao and Cherian, 1928). Ramachandra Rao *et al* (1948) studied the biology of the parasite but did not study the effect of different foods on the habits, longevity and fecundity of the adults. Dharmraju (1963) reported the influence of temperature and humidity on the life cycle of *P. nephantidis*. Since, the use of the bethylid parasite to control *N. serinopa* in the field mostly depends on the mass breeding of the parasite in the laboratory and its survivality in Nature, the present investigation was undertaken to study the food habits, behaviour to alterante hosts and the fecundity of the parasite under laboratory conditions during 1967-68.

MATERIALS AND METHODS

Cocoons of *P. nephantidis* obtained from a culture maintained in the Parasitology Laboratory of the Department of Entomology, Orissa University of Agriculture and Technology were used for the investigation. The cocoons were kept in specimen tubes for the emergence of the adults. For mating, one pair of freshly emerged adult insects was confined for 24 hours in a separate specimen tube of $7{\cdot}5 \times 2{\cdot}5$ cm which was plugged with cotton swab having a bent alpin to hold a little cotton soaked with dilute honey or sugar solution (1:1) as food for the adult. The fertilized females were transferred to glass tubes of size $5 \times 1{\cdot}5$ cm containing host larvae for oviposition. After oviposition, which could be observed by the aid of a magnifying glass, the caterpillar with eggs was transferred to a strip of paper with the help of a pair of fine forceps and fresh host larvae were provided for further oviposition. The number of eggs laid by an individual female was recorded and parasitised larvae were carefully kept to study the development of the parasites on them.

The larvae of sugarcane top shoot boror, *Scirpophaga nivella*; rice stem borer, *Tryporyza incertulas* ; brinjal shoot and fruit borer, *Leucinodes orbonalis* ; sapota leaf webber, *Nephopteryx eugraphella*; cotton boll worm *Erias fabia*; rice moth, *Corcyra cephalonica*; red flour beetle, *Tribolium castaneum*; cabbage borer, *Lasioderma binotalis* and the rice leaf roller, *Cnaphalocrosis medinalis* were provided as alternate food to explore the possibility of using a locally available insect for laboratory breeding of the parasite.

Different foods like sugar solution, honey, orange juice, Jaggary solution, crushed eggs of rice moth and water were provided as sadult food to study their effect on the fecundity of the female parasite and adult longevity. Fresh food prepared in the laboratory was provided to each parasite every day with or without a host.

Effect of relative humidity on the fecundity of the female parasite was conducted by subjecting the freshly emerged adult for oviposition at relative humidities of 50, 80 and 95% maintained in desiccators which accommodated the specimen tubes containing the parasite and the host (Solomon, 1957). Fresh hosts were provided after each oviposition.

All the experiments were conducted at laboratory temperature which varied from 23·85° to 31°C.

RESULTS AND DISCUSSION

Emergence of adults

The cocoon turned black a day or two before the emergence of the adults. Before emergence a puncture was made in the anterior tip of the cooon by means of the mandibles and the adult emerged through a hole. The process of emergence was observed to be completed in 2 to 3 minutes and males emerged earlier than the females. The females were observed to be more active, swift and strong fliers as compared to the male and could be distinguished from the male by the possession of the ovipositor.

Mating habits

The freshly emerged male and female parasites were confined in glass specimen tubes for mating. The premating period was observed to be 10—12 hours after which the male approached the female by raising the wings upwards. It mounted over the female and bent its abdomen downwards while grasping the head of the female by means of its jaws. Then it directed its genital organ into the orifice of the female genital organ. Mating continued for 2-3 minutes. Mating took place mostly during the day time and the male mated the same female several times during its life time though a single mating was sufficient to produce fertilized eggs with normal sex ratio. One male was observed to mate several females during its adulthood, but no mating was observed between old male and newly emerged female. However, the female reproduced pathenogenetically and all the progeny were males.

Oviposition

Egg laying by the parasite occurred after 1 to 3 days of parasitization of the caterpillar. Before oviposition the host was oriented to a suitable position by the parasite. The eggs were laid on the dorsolateral part of the caterpillar either singly or in masses and each oviposition was completed in 2—5 hours. The eggs were disposed longitudinally firmly adhering to the integument of the host by means of a mucilaginous substance. An instinct of the parasite was observed in the limitation of egg laying on host caterpillars of different instars. As many as 13 eggs were laid on a 5th instar caterpillar whereas, on first and second instar larvae a maximum of 3 eggs were laid during a single day. The total number of eggs laid by a female varied between 41 and 98 with a mean of 79. The 5th instar larvae of *N. serinopa* was preferred for oviposition over the other younger larvae as indicated in Table 1 which shows that 3, 6, 36, 56 and 83 eggs were oviposited on the 1st, 2nd, 3rd, 4th and 5th instar caterpillars during a period of 22 days. However, the eggs deposited on the 1st and 2nd instar larvae

Table 1

Life cycle of Perisierola nephantidis *on* Nephantis serinopa *and* Corcyra cephalonica *at a temperature of 25°C and 78% relative humidity*

N. serinopa							*C. cephalonica*					
	Replication					Average	Replication					Average
	1	2	3	4	5		1	2	3	4	5	
No. of eggs laid	89	41	92	76	98	79·2	54	83	62	86	74	71·8
No. of eggs hatched	87	41	92	66	95	76·2	48	77	56	72	74	65·4
No. of pupae obtained	84	38	91	63	92	73·6	44	71	50	66	56	57·4
No. of adults emerged												
Male : female	84	36	87	63	91	72·2	44	69	47	64	56	56
Male female ratio	1:3	1:3·5	1:3·3	1:3·5	1:31	1:33	1:39	1:3	1:3	1:3·6	1:1·3	1:3·3
Longevity of the female	30	15	30	23	37	27	20	29	30	33	29	28·2
Incubation period in days	1·5	1·5	1·5	1·5	1·5	1·5	1·5	1·5	1·5	1·5	1·5	1·5
Larval period including pre-pupal period (in days)	3·5	3·5	3·5	3·5	3·5	3·5	3·5	3·5	3·5	3·5	3·5	3·5
Pupal period including the resting period of the adult inside cocon (days)	7	8	7	6	6	6·8	7·5	8	7	8	7·5	7·6
Total developmental period (days)	12	13	12	11	11	11·8	12·5	13	12	13	12·5	12·6

could not develop as the larvae dried up before the parasite larva could feed and develop on it. On an average 92·2 per cent of the eggs hatched in about 2 days of incubation period.

Larval stage

The freshly hatched larvae somewhat resemble the eggs as the segments are not well distinguished andthey are incapable of movement. They are sacciform and slightly yellowish white in colour. They make punctures on the host caterpillar and feed. They develop gradually and the full-fed larvae are hymenopteriform in shape, reddish brown in colour and measure 3 mm in length and 1 mm in breadth. After a larval feeding period they detach from the shrunken host body and spin oval cocoons to pupate. The larval period including the prepupal period was observed to be 3·5 days (Table 1).

Pupal stage

In about a day or two of the quiescent state the larvae assumed the pupal stage which was yellowish grey in colour. After the end of the third or fourth day the colour of the pupa turned to black and assumed exarate shape. The length and breadth of the pupa varied from 4 to 5 mm and 2 to 3 mm respectively and the mean pupal period lasted 6·8 days. The duration from oviposition tc the emergence of adults was 11·8 days.

Alternate host

Full grown larvae of sugarcane top shoot borer, rice stem borer, brinjal shoot and fruit borer, sapeta leaf webber, cotton boll worm, rice moth, red flour beetle, cabbage borer and rice leaf roller were provided for 15 days to the fertilized female parasites in five replications for oviposition and development of the parasite. The parasites accepted only the larvae of *C. cephalonica* and *N. eugraphella* (Table 2). Rice moth is easy to rear in the laboratory and they could be used in mass breeding of the parasite for their use as means of biological control of the black headed caterpillar of coconut. The study of biology of the parasite on the natural host *N. serinopa* and the laboratory host *C. cephalonica* did not show much difference in the duration of total life cycle; however, in certain respects such as fecundity, percentage of viable eggs and male female ratio, *N. serinopa* was found to be a more suitable host.

Ramachandra Rao *et al.*, (1948) studied the biology of the parasite on *N. serinopa* and found the life cycle to be completed in 10—15 days. Dhaiamraju (1952) reported the total life cycle to vary from 14—16 days and could use *C. cephalonica* as its host. Antony and Kurian (1959)

found that the parasite took 8—14 days on the black headed caterpillar of coconut. The present findings indicate that the life cycle is completed in 11—13 days on *N. serinopa* and the life cycle was slightly longer when reared on *C. cephalonica*.

Table 2

Oviposition preference of P. nephantidis *on different instars of* N. serinopa *larvae and acceptance of other fullgrown caterpillars as host.*

Name of the host	Number of replications	Period in days host supplied	Average no. of eggs laid
Sugarcane top shoot borer	5	15	Nil
Rice stem borer	5	15	Nil
Brinjal shoot borer	5	15	Nil
Cotton boll worm	5	15	Nil
Cabbage borer	5	15	Nil
Rice leaf roller	5	15	Nil
Red flour beetle	5	15	Nil
Sapeta leaf webber	5	15	60
Rice moth	5	22	74
Black headed caterpillar of coconut	3	25	89

	Larval instar of *N. serinopa*				
	1st	2nd	3rd	4th	5th (Full grown)
Number of eggs oviposited	3	6	36	56	83

When adult parasites were fed with different foods, the fecundity of the insect with sugar solution and *Corcyra* egg crush was more than with any other food (Table 3). The female could live for a period of 25 days and oviposited 89 eggs during this period with sugar solution plus egg crush but it could live only for 6 days and laid about 4 eggs when only water was supplied.

Table 3

Fecundity and longevity of P. nephantidis *when fed with different types food.*

Food	Average longevity in days	Average number of eggs laid
Dilute sugar solution	28	71
Jaggery solution	22	55
Dilute honey solution	28	73
Orange juice	19	35
Sugar solution + egg crush (Eggs of rice moth)	28	89
Honey solution +egg crush	26	70
Jaggery solution+egg crush	20	56
Water	6	4

When *P. nephantidis* was reared on *N. serinopa* at relative humidities of 50, 80 and 95%, the egg laying and longevity was found to be maximum at 80% relative humidity as compared to lower or higher relative humidities. On an average 102 eggs were laid by the female which lived for a period of about 22 days.

Table 4

Longevity and fecundity of the female of P. nephantidis *at different relative humidities when dilute sugar solution was provided as food.*

Relative humidity in %	Number of replications	Average longevity in days	Average number of eggs laid
50	5	8	4·2
80	5	22	10·2
95	5	11	17

The result supports the view of Dharamraju (1963) who observed the parasite to be leathargic when atmospheric humidity was high.

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A MODIFICATION OF THE CROSSMON'S TRICHROME TECHNIQUE FOR MAMMALIAN PITUITARY

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INTRODUCTION

Crossmon (1937) suggested a very useful modification of the Mallory's (1900) connective tissue stain. Since then this technique has been widely employed for the differentiation of the acidophilic cells of the mammalian adenohypophysis (see Purves, 1961, 1966). It is generally believed that in Crossmon's trichrome technique the Lactotrophic (LTH or Prolactin) cells stain red (or purple) and the Somatotrophic (STH) cells stain orange (Hartman, Fain and Wolfe, 1946; Goldberg and Chaikoff, 1952; Dhaliwal and Prasad, 1965; see also Purves, 1961, 1966). However, Naik and Dominic (1972) reported a reversal of the staining affinity of the LTH and STH cells of the musk shrew, *Suncus murinus* L., in the Crossmon's technique. The present study was undertaken to modify and standardise the Crossmon's (1937) trichrome technique for staining mammalian pituitary in the light of the findings of Naik and Dominic (1972).

MATERIALS AND METHODS

Twelve female musk shrews, *Suncus murinus* L., at different stages of gestation were used in the study. Presence of distinct implantation sites in the uteri was used as the criterion for selecting pregnant females. The animals were trapped at night and were sacrificed in the following morning by decapitation. The pituitaries along with the adjacent parts of the brain were fixed in sublimate-formol (9:1) and sectioned sagittaly and horizontally at 5 μ. The sections were stained in the modified Crossmon's trichrome technique as per the following procedure (see Gray, 1954).

STAINING PROCEDURE

1. Hydrate sections to water.
2. Treat with Lugol's iodine for 2-3 minutes to remove mercuric chloride.
3. Place in 5% solution of sodium thiosulphate (Hypo) to remove iodine.

4. Wash thoroughly in distilled water.
5. Stain in orange G solution (orange G, 0·2 gm + glacial acetic acid, 3·0 ml+distilled water, 300 ml; or 2% orange G in 1% phosphotungstic acid) for 10—15 minutes.
6. Stain in Acid fuchsin—orange G mixture (acid fuchsin, 1·0 gm+ orange, G, 0·4 gm + glacial acetic acid, 2·0 ml + Thymol, 0·2 gm + distilled water, 300 ml) for 1-2 minutes.
7. Rinse sections in distilled water.
8. Differentiate in 10% phosphotungstic or phosphomolybdic acid.
9. Give a quick rinse in distilled water.
10. Stain for 5—7 minutes in light green (light green, 1·0 gm + distilled water, 100 ml+glacial acetic acid, 1·0 ml) or Anilin: blue (aniline blue 2·0 gm +distilled water, 100 ml +glacial acetic acid, 2 ml.) solution
11. Quickly rinse in distilled water.
12. Differentiate in 1% acetic acid.
13. Rinse briefly in distilled water.
14. Dehydrate quickly in absolute alcohol and mount, preferably in DPX.

RESULTS

LTH (Pralactin) cells	...	orange
STH cells	...	red
mucoid cells	...	green (or blue)

DISCUSSION

It has been shown that the LTH (Prolactin) and the STH cells of the rat (see Purves, 1961, 1966), dog (Hartman, Fain and Wolfe, 1946 ; Goldberg and Chaikoff, 1952) and palm squirrel (Dhaliwal and Prasad, 1965) are stained red (or purple) and orange (or yellow) respectively in the Crossmon's (1937) trichrome technique. On the contrary, the original technique of Crossmon (1937) does not yield consistent differentiation of the acidophilic cells in the case of the musk shrew as has also been reported by Naik and Dominic (1972). However, when the technique is modified, as described above, two types of acidophilic cells are clearly differentiated in the pituitary gland of the musk shrew. The cells which are stained orange in the modified technique are extremely hypertrophied and are in great abundance. In some of these cells, the negative image of the Golgi zone is clearly seen. On the other hand, the cells which are stained red are fewer in number, comparatively smaller in size and are somewhat polygonal or enlongated in shape. Since it is wellknown that the LTH cells exhibit intense secretory acivity and are greatly hypertrophied during pregnancy, the orange coloured cells in the case of the musk shrew are,

in all probability, LTH cells and the red ones are STH cells (see Naik ,1972). A more or less similar staining of these two cell types of the musk shrew pituitary results after applying the Matsuo's tetrachrome technique (Matsuo, 1954), in which , as in the modified Crossmon's technique, the sections are first stained with an aqueous solution of orange G before staining them with the acid fuchsin solution. It is significant to mention here that the staining reactions of the LTH and STH cells of the musk shrew with respect to Heidenhain's trichrome, Mallory's trichrome, Cleveland-Wolfe trichrome and Herlant's tetrachrome techniques correspond with that of other mammals (see Naik and Dominic, 1972). Consequently the staining reaction of the LTH and STH cells of the musk shrew in the modified Crossmon's technique is contradictory to the findings in rat, dog and palm squirrel (see above). However, it is not possible to say at this stage whether the reversal in the staining reaction is due to an inherent difference of these two cell types of the musk shrew from that of other mammals or due to the modification in the technique itself. This question can be answered only after staining pituitaries of other mammals with known tinctorial property in the modified Crossmon's technique which has been employed in the present study. This problem is currently under investigations.

SUMMARY

The LTH and STH cells of the pituitary gland of certain mammal stain red and orange respectively in the Crossmon's trichrome technique. It is not possible to achieve tinctorial differentiation of these two cell types in the case of the musk shrew by the same technique. Therefore, the original technique has been successfully modified. This modification of the technique has been described in detail. However, in the modified technique, the tinctorial affinity of the two cell types of musk shrew is reversed. The possible significance of this reversal in the staining affinity is discussed.

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A STUDY ON THE ROLE OF PREGNANCY AND CHILD BIRTH IN CAUSATION OF UTERINE PROLAPSE

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INTRODUCTION

Prolapse of uterus is not a very uncommon condition among Indian women. Although sufficient data are not available to support this fact, it is observed by some that the incidence of prolapse is high. Specially, in rural areas, where adequate health facilities are not available and trained assistance at the time of delivery is rare or limited, it is likely that incidence of prolapse will be high. Chandra *et al*[3] studied the incidence of prolapse among pregnant women in a rural area near Lucknow and found that 35·9% of the women suffered from uterovaginal prolapse of different degrees.

Various factors have been attributed by different authors for causation of prolapse. Posture during child birth [1, 3, 10] injury to the birth passage due to precipitate labour or instrumentation, [2, 4, 6] inadequate or weakly supporting perenial tissue [7, 8, 9] advancing age [1, 4, 5, 9, 12] and menopause causing slackness of tissue[4], chronic cough [2, 4] constipation, obesity [4, 6] etc. are some of the important aetiological factors which bring about prolapse. Though prolapse is more common among multiparous women, it cannot be ruled out among nulliparous women [1, 2, 4]. Congenital prolapse although rare, cases have been reported [3, 10]. Some also report that uterovaginal prolapse is more common in particular families[3]. Rapid succession of pregnancy and birth are described as most important aetiological factors [2, 4] However, increased intra-abdominal pressure [8, 10] caused by chronic cough, ascitis, tumours and straining during parturition or defaecation (specially due to chronic dysentery or constipation) bring about downward descent of utreus.

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In the present study, an attempt has been made to bring out some of the host factors which are likely to influence occurrence of prolapse.

MATERIALS AND METHODS

A study of the health problems of the aged people was undertaken in seven sample villages of Rural Health Centre, Jagatsinghpur, under Department of Social and Preventive Medicine, S.C.B. Medical College, Cuttack. In the study population, there were 237 women of 55 years and above. 43 cases (18·14%) of uterine prolapse (third degree and procidentia only) were enccuntered among these women. To elucidate the role of various factors in causation of uterine prolapse, it was considered desirable to compare the characteristics of the prolapse cases with the same among a group of unaffected individuals from the study population, with special reference to the attributes that are likely to be associated with the causation of prolapse. For the said purpose, the controls matched for age only, were selected from the women wihout uterine prolapse by paired random sampling technique.

As the material was collected in the course of a field survey by house to house visit, it was not possible to conduct P.V. examination of all the women under investigation. In this case, rather P.V. examination of women in their houses was deliberately avoided to get full co-operation of villagers and the women concerned. Diagnosis of prolapse was based on descent of the uterus below introitus without straining, as such, this includes only third degree prolapse and procidentia. However, for diagnosis, the vulva was inspected by the investigator in the presence of a lady field worker like A.N.M. or L.M.V. Thus the picture of uterovaginal prolapse seen here is rather limited, as by a thorough gynaecological check up is likely to reveal more number of such cases of 1st and 2nd degree for which presumably the figure of this study (18·14%) is much lower than 35·9% as reported by Chandra *et al.*[3]

OBSERVATIONS AND DISCUSSION

In the study group, prolapse cases were encountered among all the groups of women and the proportion having uterine prolapse shows a positive correlation with ageing (Table No. 1).

However, analysis reveals that, 30 cases (69·8%) had prolapse before menopause and 13 cases (30·2%) had after menopause, which supports that obstetrics trauma is undoubtedly the chief cause[12]. Such an observation subscribes to the view that atrophy of supporting structures which

accompanies ageing process may be one of the dominating factors in development of procidentia.

Table 1

Age distribution of uterine prolapse among study population

Age group	Total number of women under study	Number of Prolapse cases	Percentage
55—59	86	11	12·8
60—64	59	10	16·9
65—69	36	8	22·2
70—74	31	8	25·8
76—79	14	5	35·7
80+	11	1	9·9
Total	237	43	18·1

Here, it may not be out of place to bring further that, the present observations were made on women of 55 years and above, who had their child bearing period at least 10 years before. The survey ended in July, 1970. Therefore, these groups of women had their last delivery before 1960. As the women belonged to rural area where even now indigenous *dais* conduct delivery, it is most likely that almost all of them delivered their babies in most primitive condition without much scientific obstretical aid. As such impact of obstretic trauma is likely to be important in this group. However the data in the present study will serve as a base line of comparison with women having good obstretical care, which may reveal impact of good obstetric care on women.

Obstetric history was collected from both the study and control groups to identify attributes related to causation of prolapse (Table 2).

It was observed that age at menarchae and at memopause are similar in both groups indicating that both the groups belong to the same universe having similar physiological characteristics. In the prolapse group, age at first delivery was 18·1 years and age at last delivery 35·9 years and in control group the figures are 20·1 years and 32·3 years respectively. Hence the span of actual child bearing period differs substantially between two groups *i.e.*, 17·8 years and 12·2 years respectively. Similar difference is also observed with respect to pregnancies and full term deliveries between the

Table 2

Obstetric data of prolapse and control cases

Attributes	Study Group	Control Group
Age at menarchae	14·5 yr.	14·4 yr.
Age at menopause	14·6 yr.	44·9 yr.
Age at first delivery	18·1 yr.	20·1 yr.
Age at last delivery	35·9 yr.	32·3 yr.
Total no. of pregnancies	5·4	3·8
Total no. of full term deliveries	4·6	3·2
Interval between births	3·4 yr.	5·1 yr.
Interval between pregnancies	3·07 yr.	4·3 yr.

study and control groups. Further it is also seen that the interval between the pregnancies and full term births in control group is longer than that in the study group. Thus it can be safely concluded that pregnancy and child birth in quick succession or spreading over a longer period in reproductive age of women increases the chance of uterine prolapse in women.

The total number of pregnancies and full-term birth among prolapse and control cases were tabulated by taking family planning norm of 3 children into consideration (Tables No. 3 & 4).

Table 3

Total number of pregnancis among cases and controls

Total number of pregnancies	Prolapse cases	Control cases	Total
0—3	6 (24·0%)	19 (76·0%)	25 (100%)
4—6	26 (55·3%)	21 (44·7%)	47 (100%)
6+	11 (78·6%)	3 (21·4%)	14 (100%)
Total	43	43	86

Implementation of Family planning and welfare as a national programme which envisages the target of having 2 or 3 children per couple, there is a need to measure quantitatively the actual health benefits the mothers get out of such programme. Thus attempts were made to study the effect on mothers' reproductive organ dividing the study and control groups as 3 pregnancies or less and more than 3 pregnancies and full term births.

Table 4

Total number of full term deliveries among cases and controls

Number of full term deliveries	Study Group	Control Group	Total
0—3	12 (31·6%)	26 (68·4%)	38 (100%)
4—6	26 (61·9%)	16 (38·1%)	42 (100%)
6+	5 (83·3%)	1 (16·7%)	6 (100%)
Total	43	43	86

Datas in Tables 3 and 4 indicate that mothers having 3 or less number of pregnancies and births have a lesser chance to become victim of uterine prolapse. X^2 test was applied to test the statistical significance which in both cases was found to be significant ($P < 0{\cdot}05$). Further data in the present study for drawing such conclusion is more suited as the women in the study have enjoyed their reproductive life prior to mass application of contraceptive measures.

The spacing between pregnancies and interval between births were also studied among two groups (Tables 5 & 6).

Table 5

Average interval between two pregnancies

Interval in years	Study Group	Control Group	Total
3 years and less	23 (65·7%)	12 (34·3%)	35 (100%)
More than 3 years	18 (41·8%)	25 (58·2%)	43 (100%)
Total	41*	37**	78

*2 women had only 1 pregnancy each

**6 women had only 1 each or no pregnancy

Table 6

Average interval between full term deliveries

Interval in years	Study Group	Control Group	Total
3 years and less	25 (65·8%)	13 (35·2%)	38
More than 3 years	16 (41·0%)	23 (59·0%)	39
Total	41*	39**	77

*2 women had one delivery each
**Seven women had 1 each or no delivery

In the family planning programme, attempts are also made to increase the interval between pregnancies and full term deliveries by use of contraceptives. This analysis was made to assess the effect of such interval and occurrence of uterine prolapse in mothers (Tables No. 5 & 6). It is observed that the uterine prolapse occurs more frequently when the gap between two pregnancies or births is less than 3 years. Data on statistical test was also found to be significant ($P<0·05$).

The ageing process increases the chance of prolapse in every woman. But those who have suffered much stress and strain during child bearing period, the prolapse may occur in earlier age and may be aggravated or complicated during the process of ageing. However the family planning slogan of small family (*i.e.*, less than 3 births) and increased spacing between pregnancies are beneficial for the women and occurrence of prolapse can be prevented by following these advice.

SUMMARY AND CONCLUSION

43 women with uterine prolapse along with age matched control were studied with respect to the personal characteristics like span of actual child bearing period, number of pregnancies and full term births and interval between pregnancies and full term births. It is seen that women having less number of pregnancies and births with great interval between pregnancies have less chance of developing uterine prolapse. Further, women having less than 3 pregnancies or births and having more than 3 years interval between same are less prone to prolapse. Here in this study third degree of prolapse and procidentia were included.

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STUDIES ON CERTAIN ASPECTS OF REPRODUCTIVE FUNCTION AND BIONOMICS OF *BUFO MELANOSTICTUS* SCHNEID

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ABSTRACT

Results of study of certain aspects of reproductive function and bionomics of *Bufo melatnostictus* Schneid are reported. Sperm ejaculation response of male toads to injections of chorionic gonadotrophin or pregnant women's urine was obtained throughout the year. Histological examination of testes and ovaries in different seasons revealed clear cut evidence of active spermatogenesis and oogenesis respectively. However although enormously proliferated ovary was exhibited in all adult female toads of this species during the monsoon months, in other seasons, such proliferated ovary was present only in a certain percentage of the female animals. Stimulation of vago-sympathetic trunk showed predominance of sympathetic system during winter months and the reverse was true during the summer. The data presented indicate that in Eastern India in toads of this species, gametogenesis goes on all the year round and that these animals do not go into hibernation or aestivation. However, their mating and breeding habit may not run parallel with gametogenesis in different seasons.

INTRODUCTION

The frogs and toads have a well demarcated breeding season. Their bionomics is interesting in that they go into hibernation or aestivation depending on climatological conditions of their environment. During such torpid state either in winter or in summer, it is natural to expect that gametogenesis would remain suspended. Yet in course of work on sperm test of pregnancy and other studies on gonadotrophins[1–5] the first author observed that in male toads, *Bufo melanostictus* Schneid., spermatogenesis goes on throughout the year as judged by the response of sperm ejaculation when chorionic gonadotrophin or urine of pregnant women which contains this hormone is injected. Further, in course of routine work, it was noted that during summer and winter months, which is believed not to be their breeding season, quite significant number of adult female toads of this species exhibited ovarian proliferation and follicles in different stages of development. Such observations indicated that both in male and female

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toads gametogenesis goes on more or less throughout the year and this raised the question if this species of toads in this part of the world enters at all into hibernation or aestivation. To get an answer to this question and to throw more light on gametogenesis it was thought worthwhile to study this problem, particularly in view of wide use of this species of toads in biological tests of pregnancy as well as bioassay of chorionic gonadotrophin in some centres. A preliminary report of this study[6] was published in 1957. Subsequently other workers [7–9] in this and other countries studied on one or other aspect of this problem and the results of their study corroborate the preliminary findings of the authors of this paper. This paper embodies the results of more detailed investigations carried on repeatedly in three widely separated places in Eastern India, namely, Cuttack, Burla and Muzaffarpur.

METHODS

(*a*) *Macro and microscopic examination of ovaries for evidence of oogenesis* :

Round the year female toads belonging to the said species were freshly caught from nature every fortnight and their ovaries were examined macro- and microscopically for their proliferation and for histological evidence of active oogenesis respectively and a regular record of the number examined and the number showing proliferated ovary and the presence of follicles in different stages of development was maintained. For microscopic examination, both stained and unstained sections of ovaries were prepared and used.

(*b*) *Examination of male toads for evidence of spematogenesis* :

The male toads of this species were used twice a week or more frequently in performing the sperm test of pregnancy as a routine work. Histological sections of testes prepared in different seasons were also examined microscopically to find out the condition of the germinal epithelium of the seminiferous tubules and signs of active spermatogenesis.

(*c*) *Study of previously marked toads during mid-winter and mid-summer months* :

This species of toad is notorious for inhabiting and taking shelter in dark, cool places and unfrequented corners and crevices of dwellings and in their neighbourhood. During the autumn and the spring respectively a sizable number of such toads were caught from dwelling houses and the neighbourhood and on each animal a small specially prepared metal ring was fixed on the skin near one of the parotoid glands. At the height of the succeeding winter and summer respectively regular searches were made for

Table 1

Examination of adult female toads for the presence of proliferated ovary in different months

Season	Month	Fortnight	Number of animals examined	Number showing proliferated ovary	Percentage showing proliferated ovary	Remarks
	November	1st	252	96	38·09	
		2nd	248	64	25·80	
Winter	December	1st	250	48	19·20	
		2nd	259	46	17·76	
	January	1st	258	51	19·72	
		2nd	256	44	17·18	
	February	1st	249	53	21·28	
		2nd	255	50	19·60	
	March	1st	247	45	18·21	
		2nd	251	43	17·13	
	April	1st	245	24	9·79	
Summer		2nd	260	27	10·38	
	May	1st	250	7	2·80	
		2nd	257	24	9·33	
	June	1st	249	31	12·44	
		2nd	253	73	28·85	
	July	1st	263	210	79·84	
		2nd	259	258	99·61	
	August	1st	255	255	100·00	
Rainy		2nd	251	251	100·00	
	September	1st	257	257	100·00	
		2nd	259	259	100·00	
	October	1st	259	229	88·41	
		2nd	247	198	80·16	

these animals with rings in and around the places of their habitation and all those spotted out were caught. The general condition, behaviour and activity of those caught were noted. All the female animals were dissected and their ovaries were studied both macro and microscopically, using for the latter method, stained and unstained sections of ovaries. The sperm ejaculating reaction of male toads were studied by injecting standard preparations of chorionic gonadotrophin or pregnant women's urine. Histological sections of testes were also studied for obtaining evidence of active spermatogenesis or otherwise.

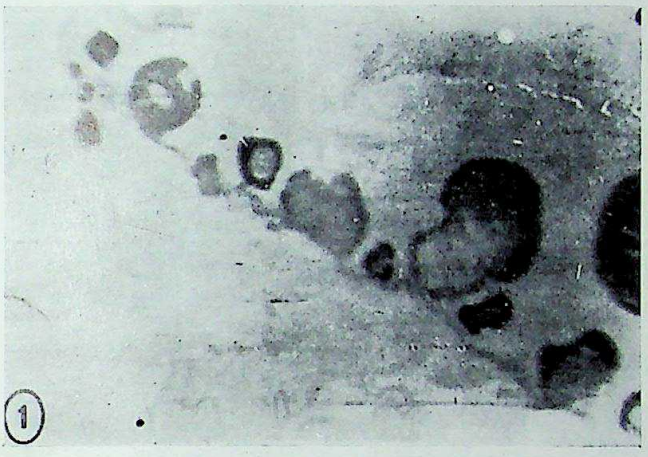
Further the vago-sympathetic trunk of some of these animals, both male and female, were stimulated and kymographic records obtained to find out whether the vagus or the sympathetic was predominant in that particular season.

RESULTS

Tables 1 and 2 present the results of examinations of ovaries round the year for their proliferation and presence of follicles in different stages of development respectively. Examination of these two tables shows that almost cent per cent of the adult female animals' ovaries were found proliferated and studded with developing follicles during the monsoon months, which period is their breeding season. During other months of the year the percentage of female toads whose ovaries were found proliferated varied depending on the season ; it was lowest during mid-summer and not during mid-winter contrary to authors' expectations. However whether the ovaries were proliferated or not, on microscopic examination they invariably revealed follicles in different stages of development. Microphotograph of a histological section of ovary in the summer months, during which season, the percentage of female toads showing proliferated ovary was the lowest, in presented is Fig. 1. Examination of Tables 1 and 2 and Fig. 1 clearly indicates that oogenesis goes on throughout the year, might be in varying tempo in different seasons.

Table 3 presents data on sperm ejaculating response of male toads to injections of human pregnancy urine or chorionic gonadotrophin in different months of the year. Table 4 shows the results of histological study of toads' testes for evidence of active spermatogenesis in different seasons. Examination of histological sections of testes prepared in different seasons exhibited always a picture of active spermatogenesis. Actively dividing cells of the germinal epithelium, spermatids and spermatozoa, were present in abundant number. The lumen of the seminiferous tubules were literally filled with bundles of fully developed spermatozoa. Such histological evidence is shown in the microphotographs in Figs. 2 and 3, which were

Prakruti—Utkal University Journal—Science
Vol. 9 (1—2) : 29—36, 1972



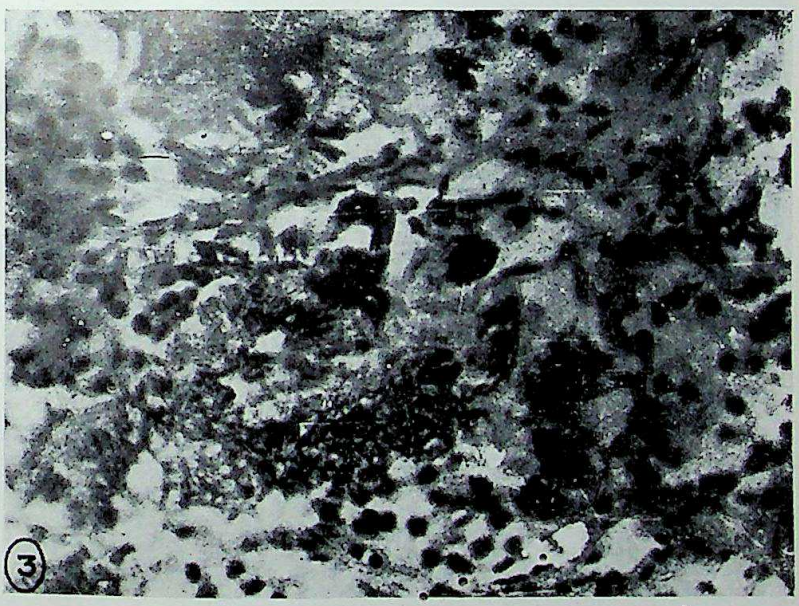


Fig. 1. Microphotograph of histological section of ovary of toads during summer showing different stages of development of follicles. Magnification—45×6.

Fig. 3. Microphotograph of histological section of testis of toads during summer showing seminiferous tubules filled with spermatids and spermatozoa. Magnification—20×10.

Fig. 2. Microphotograph of histological section of testis of toads during winter showing seminiferous tubules filled with spermatids and spermatozoa. Magnification—20×15.

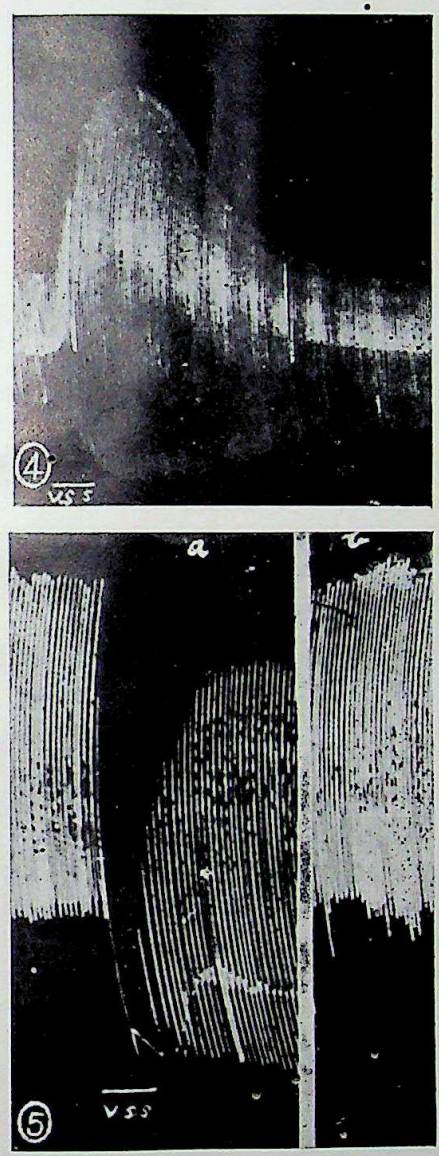


Fig. 4. Kymographic record of toad's heart beats during winter showing effect of stimulation of vagosympathetic trunk. Speed : 1·2 mm/sec. VSS=Duration of Vagosympathetic stimulation.

Fig. 5. Kymographic record of toad's heart beats during summer showing effect of stimulation of vagosympathetic trunk. Speed : 2·5 mm/sec.
(*a*) VSS=Duration of vagosympathetic stimulation.
(*b*) After 10 minutes interval.

prepared with specimens of testes collected in winter and summer months respectively. Study of these figures as well as tables 3 and 4 clearly indicates that spermatogenesis goes on throughout the year and the difference in the intensity of this physiological function in different seasons, if there is any, is hardly discernible from histological study of testes.

Table 2

Histological study of ovaries of adult female toads for evidence of active oogenesis in different seasons

Season	Month	Number of animals studied	Number showing active oogenesis	Percentage showing active oogenesis
Autumn	November	45	45	100
Winter	January	48	48	100
Spring	March	40	40	100
Summer	May	35	35	100
Rainy	August	50	50	100

Table 5 presents the data of animals on whom metal rings were fixed during the autumn and spring seasons. Those of them which were found out and caught during the succeeding winter and the summer respectively were studied as has been described before. There was nothing abnormal in their behaviour and activity. Results of study on spermatogenesis and oogenesis of these toads were very much similar to those obtained with toads caught from nature from different localities in winter and summer months. It seems slightly differing environmental factors prevalent in different localities of the region do not influence the physiological behaviour of these animals.

Figures 4 and 5 are reproductions of sample kymographic records of heart beats on stimulation of vago-sympathetic trunk of toads. The experiments were performed in mid-winter and mid-summer months respectively. These records indicate that the sympathetic was predominant during winter months and the vagus during the summer.

Table 3

Sperm ejaculating response of adult male toads to injections of human pregnancy urine or chorionic gonadotrophin in different months

Season	Month	Number of toads utilised	Number of toads having sperm ejaculation	Percentage of positive response	Remarks
Winter	November	283	283	100	
	December	271	271	100	
	January	277	277	100	
	February	280	280	100	
Summer	March	291	291	100	
	April	285	285	100	
	May	282	282	100	
	June	305	305	100	
Rainy	July	293	293	100	
	August	297	297	100	
	September	286	286	100	
	October	304	304	100	

Table 4

Histological study of testes of adult male toads for evidence of active spermatogenesis in different seasons

Season	Actual month of study	Number of animals used	Number showing active spermato-genesis	Percentage showing active spermato-genesis
Autumn	November	33	33	100
Winter	January	36	36	100
Spring	March	30	30	100
Summer	May	38	38	100
Rainy	August	35	35	100

Table 5

Examination of adult toads set free with fixed metal rings during autumn and spring and caught in succeeding Winter and Summer months respectively

Season	Months	No. of toads set free with fixed metal rings		No. of toads caught in succeeding season		Percentage caught		Remarks
		Male	Female	Male	Female	Male	Female	
Autumn	November	122	356					
Winter	January			11	37	9·01	10·39	
Spring	March	116	330					
Summer	May			7	28	6·03	8·48	

DISCUSSION

Examination of the data presented clearly shows that in Eastern India, gametogenesis both in males and females of this species of toads, *B. melanostictus*, goes on throughout the year although the tempo might vary in different seasons. Perhaps it is most intense during rainy months, which is their breeding season. Whether reproductive activity runs parallel with gametogenesis is not clear. Rather inspite of active oogenesis throughout the year, presence of proliferated ovary only in a small percentage of female toads in winter and summer months stands in contrast with the finding of such proliferated ovary in hundred per cent of adult female animals in rainy season. This perhaps indicates that mating and breeding habit might not run parallel with gametogenesis.

Very satisfactory sperm ejaculating response of male toads to injections of chrionic gonadotrophin or human pregnancy urine all the year round indicates that the difference in intensity of spermatogenesis in different seasons, if there is any is not discernible on the results of this biological reaction and therefore it is unlikely to vitiate the accuracy of pregnancy test or bio-assay of gonadotrophin performed by using these toads as test animals.

The presence of developing follicles in the ovaries of female animals in all seasons and signs of active spermatogenesis in testes and ejaculation of sperms by males throughout the year on injection of gonadotrophin or pregnant women's urine which contains ganodotrophin lead to the conclusion that this species of toads very likely never go into hibernation or aestivation in Eastern India. Predominance of sympathetic system during winter months also lends support to the assumption that this species of toads does not go into hibernation.

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ON THE MORPHOLOGY AND HISTOLOGY OF THE ALIMENTARY CANAL AND ASSOCIATED ORGANS OF THE WATER BEETLE, *CYBISTER LIMBATUS* FABR.

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ABSTRACT

The morphology and histology of the alimentary canal and its associated organs in *Cybister limbatus* Fabr. have been studied.

INTRODUCTION

The morphology and histology of the alimentary canal of different groups of Coleoptera are scarce in the literature (Deegener, 1910 ; Rungius, 1911 ; Korschelt, 1924 ; Landis, 1936 ; Patterson, 1937 ; Strambi, 1970, and Ekis and Gupta, 1971). Strambi (1970). and Ekis and Gupta (1971) have done extensive work respectively on 8 species of the family Catopidae and on 44 species of the family Cleridae. Deegener (1910), Rungius (1911) and Korschelt (1924) worked on the water beetle, *Dytiscus*. The present investigation deals with the morphology and histology of the alimentary canal of *Cybister limbatus* Fabr. (Dytiscidae) which appears not to have been worked out so far.

MATERIALS AND METHODS

Adult specimens of *C. limbatus* were collected near the light posts during the period August to October 1973 at Bhubaneswar and from ponds at different times during the year. They were killed in hot water (60°C) and dissected in normal saline. Different parts of the alimentary canal were fixed in aqueous Bouin's solution for about 4 hours. The fixed materials were passed through different grades of alcohol, xylene and then to paraffin wax. Blocks were prepared by paraffin embedding. Sections were cut at the thickness of 5—7 μ and stained in Delafield's hematoxylin and eosin. After passing through different grades of alcohol the sections were mouted in balsam. Clove oil and xylene were used as clearing agents.

MORPHOLOGY

The alimentary canal (Fig. 1) of *C. limbatus* is about four times longer than the total length of the body and is about 14 cm in length in the adult insects. It consists of three parts *viz.*, foregut or stomodaeum, midgut or mesenteron (Ment) and hindgut or proctodaeum.

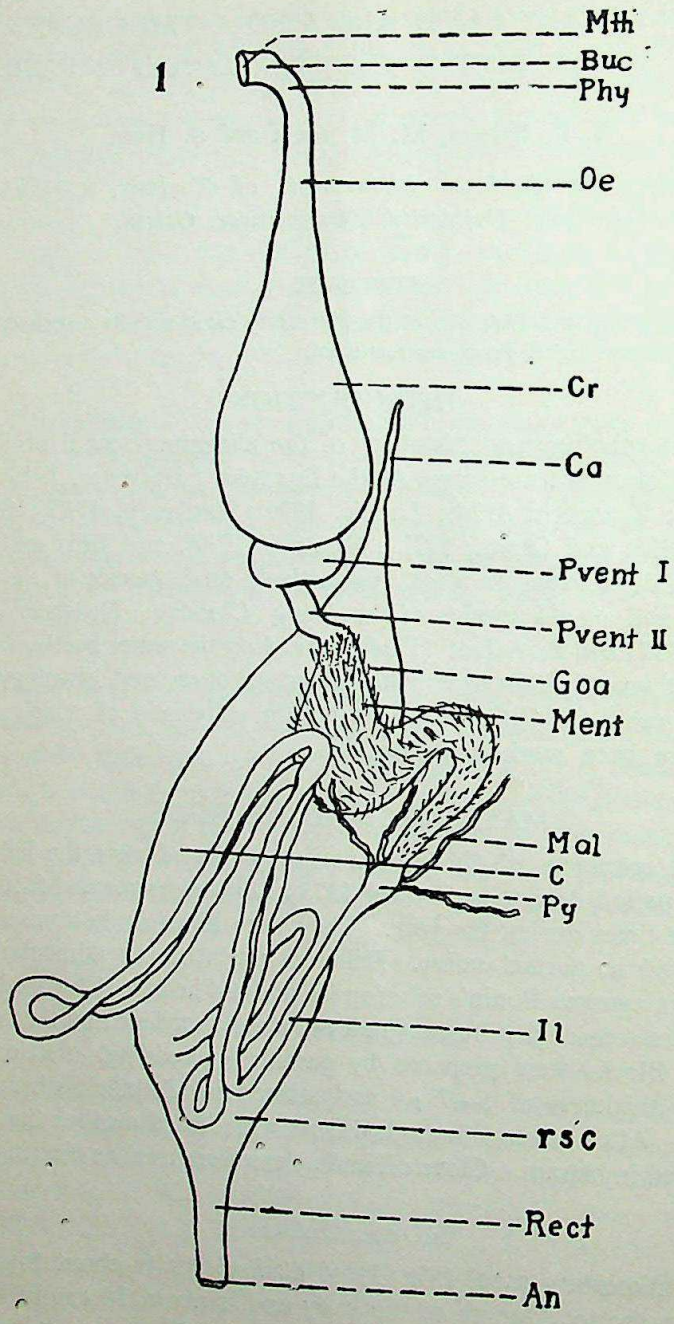


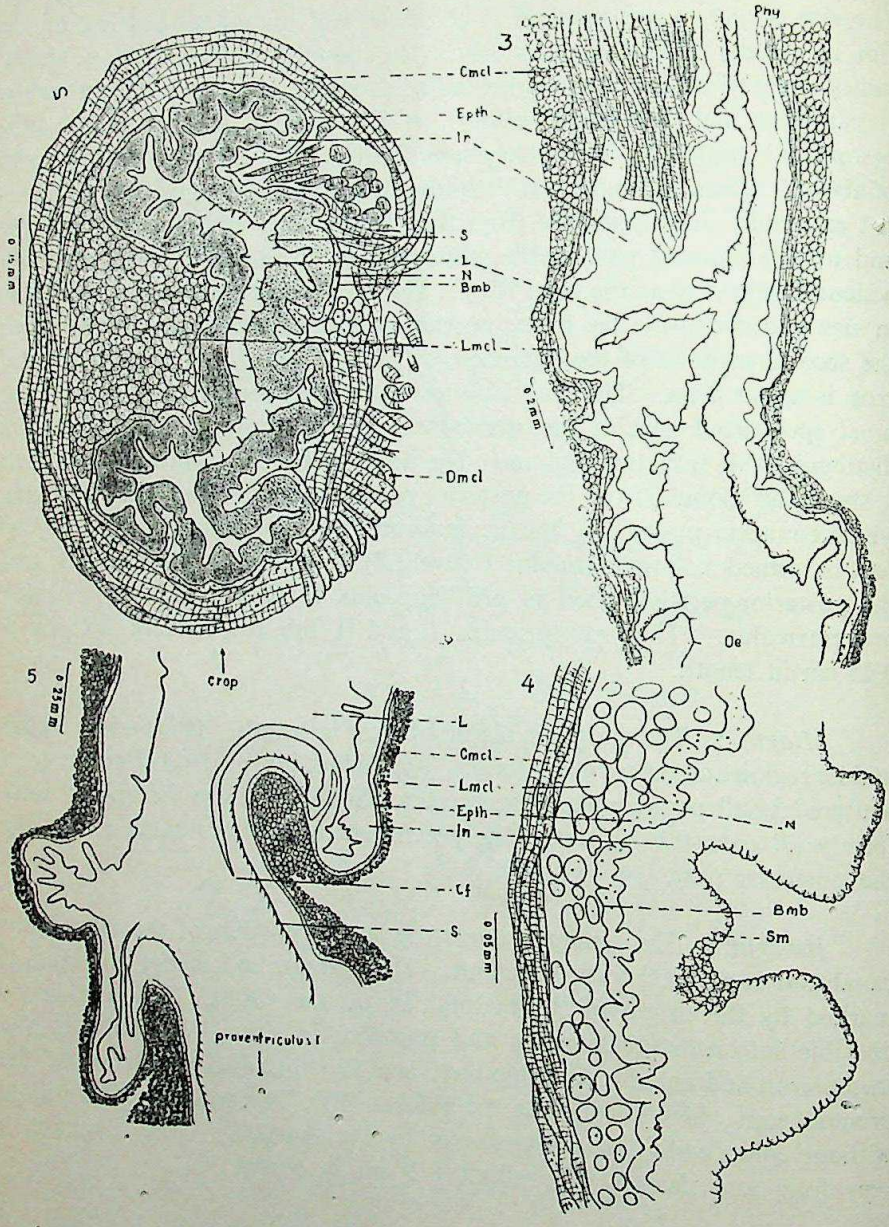
Fig. 1. *Cybister limbatus* Fabr., alimentary canal.

Foregut : The foregut is about 2·75 cm in length. It begins at the mouth (Mth) which is situated at the base of the chewing apparatus. The rim of the mouth opening is chitinous and the dorsal portion of the rim is slightly extended anteriorly. The mouth is followed by a buccal cavity (Buc) which is continued behind as the pharynx (Phy). The pharynx is narrower than the buccal cavity. It lies between the brain and sub-oesophagal ganglion. The pharynx is a short, straight and narrow tube of about 0·45 cm in length. It is followed by the oesophagus (Oe) which is not externally distinguishable from the pharynx. It is a slender, narrow and undifferentiated part of the stomodaeum. The oesophagus gradually widens posteriorly as the crop (Cr). The crop is very capacious, variable in size and constitute the major portion of stomodaeum. It extends upto the second segment of the abdomen. The total length of oesophagus and crop is about 2 cm. The crop is followed by the proventriculus. It is the most specialized part of the stomodaeum. The proventriculus is clearly distinguishable into two regions. The anterior portion following the crop is short and globular, and the posterior part is a narrow tubelike structure which connects posteriorly the mesenteron. For convenience, the anterior part is termed as proventriculus I (Pvent I) or anterior proventriculus and the posterior part is termed as proventriculus II (Pvent II) or posterior proventriculus. The proventriculus I and II are respectively 0·15 and 0·25 cm in length.

Midgut : The midgut is about 1·85 cm in length. It is wider in the middle region and tapers posteriorly. The midgut is provided with numerous scattered small papillae-like gastric caeca (Gca) which are distributed uniformly all over the surface. The gastric caeca becomes smaller towards the posterior part.

Hindgut : The hindgut covers the largest portion of the alimentary canal and is about 9·5 cm in length. The anterior end of the hindgut is marked by the origin of the malpighian tubules (Mal). The hindgut is divisible into anterior intestine and posterior intestine. In between the mesenteron and anterior intestine there is a short but distinct portion of the proctodaeum which is called as the pylorus (Py). The anterior intestine is without colon and is represented only by the ileum (Il). The ileum is a very long and narrow tube about 8·5 cm in length.

The posterior intestine is dilated anteriorly into rectal sac (rsc) and narrowed gradually posteriorly into a straight tube, the rectum proper (Rect) which directly opens into the anus. The ileum opens at the side of rectal sac which extends anteriorly to form a blind pouch called caecum (C). The caecum is very extensible, capacious and when fully dilated, extends



Figs. 2—5. *Cybister limbatus* Fabr., 2—T. S. pharynx, 3—L. S. pharynx and oesophagus, 4—T. S. crop (a portion magnified), 5—L. S. crop and proventriculus.

upto the mesothoracic region. The caecum terminates distally in a narrow, solid, tubular structure called caecal appendix (Ca).

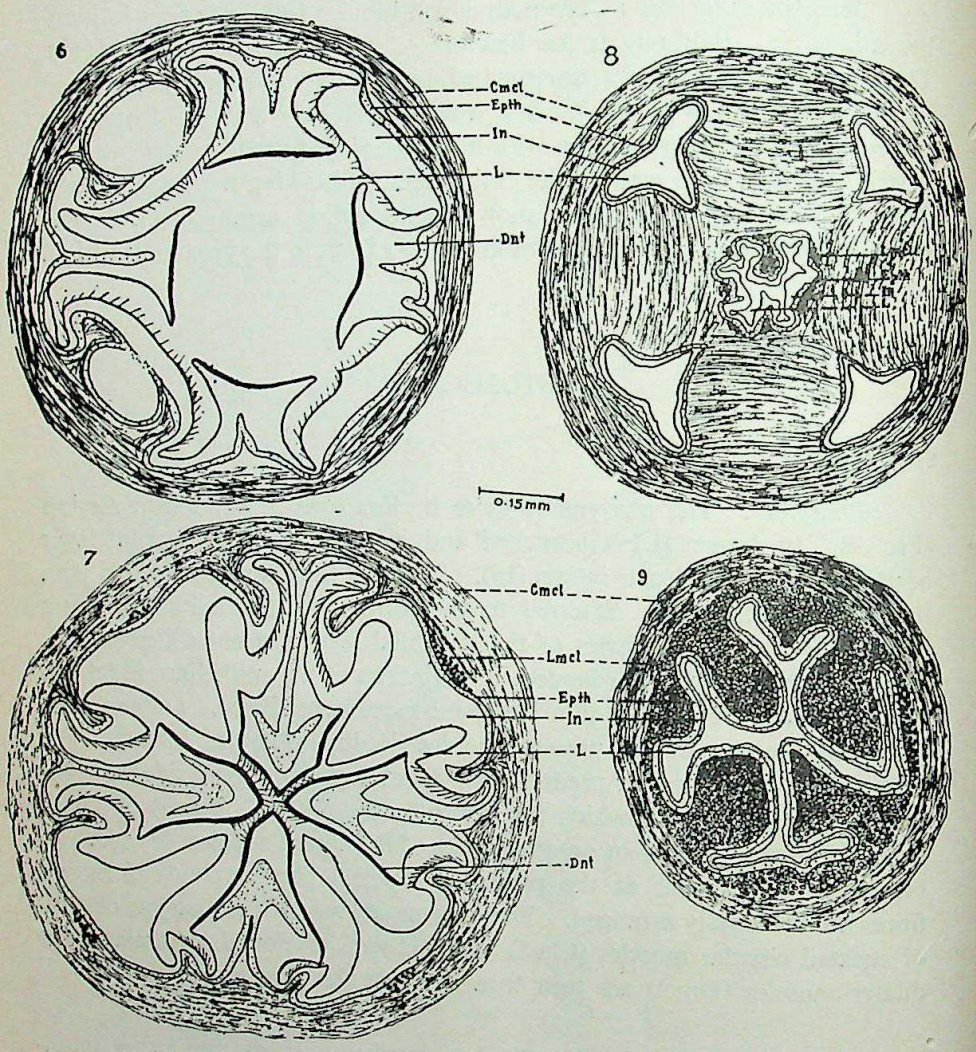
Malpighian tubules : The malpighian tubules (Mal) are four in number and arise separately at the junction of the midgut and the hindgut. These are very long, slender, unbranched, highly convoluted and more than 12 cm in length. The tubules first ascend anteriorly and coil round the mesenteron in close association with it. Then they descend posteriorly and closely adhere to the wall of the entire ileum, following a zig-zag course. Thus the malpighian tubules show cryptonephric arrangement. The malpighian tubules are deep brown in colour except in the proximal portion.

HISTOLOGY

STOMODAEUM

Pharynx : The pharynx is more or less oval in transverse section (Fig. 2). Its lumen (L) is branched and constricted. The internal layer of pharynx is the cuticular intima (In). It is very thick and is provided with transparent spines (S). External to the intima lies the epithelial layer (Epth). The cell boundaries of the epithelial layer are not differentiated. Its nuclei (N) are oval to rounded. The intima of the epithelium is folded. The epithelium rests on a thin basement membrane (Bmb). Outer to the basement membrane are present the longitudinal muscles (Lmcl). The longitudinal muscles are predominantly developed on one side of the pharynx, as a result of which the lumen is constricted. Traces of longitudinal muscles are present on other sides of the anterior region of pharynx but, these are absent at the posterior region. The longitudinal muscle fibres are compactly arranged. The outermost layer of the pharynx consists of striated circular muscles (Cmcl) which is well developed. At places the dilater muscles (Dmcl) are seen to arise from the pharynx.

Oesophagus : Histologically the oesophagus shows the same fundamental arrangement as that of the pharynx. The lumen of it is not compressed and is not branched like that of the pharynx. The intima is thick and the portion towards the lumen takes deep eosin stain. It is provided with small crystalline spines. The epithelium seems to be syncytial. Both the epithelium and intima are folded. Here the folds are more prominent in comparison to pharynx. The epithelium rests on a basement membrane. The longitudinal and circular muscles form continuous layer of uniform thickness, and both the layers are less developed than in pharynx (Fig. 3).



Figs. 6—9. *Cybister limbatus* Fabr., 6—T. S. anterior proventriculus I, 7—T. S. posterior proventriculus I with sharp cutting edges, 8—T. S. in between proventriculus I and II, 9—T. S. proventriculus II.

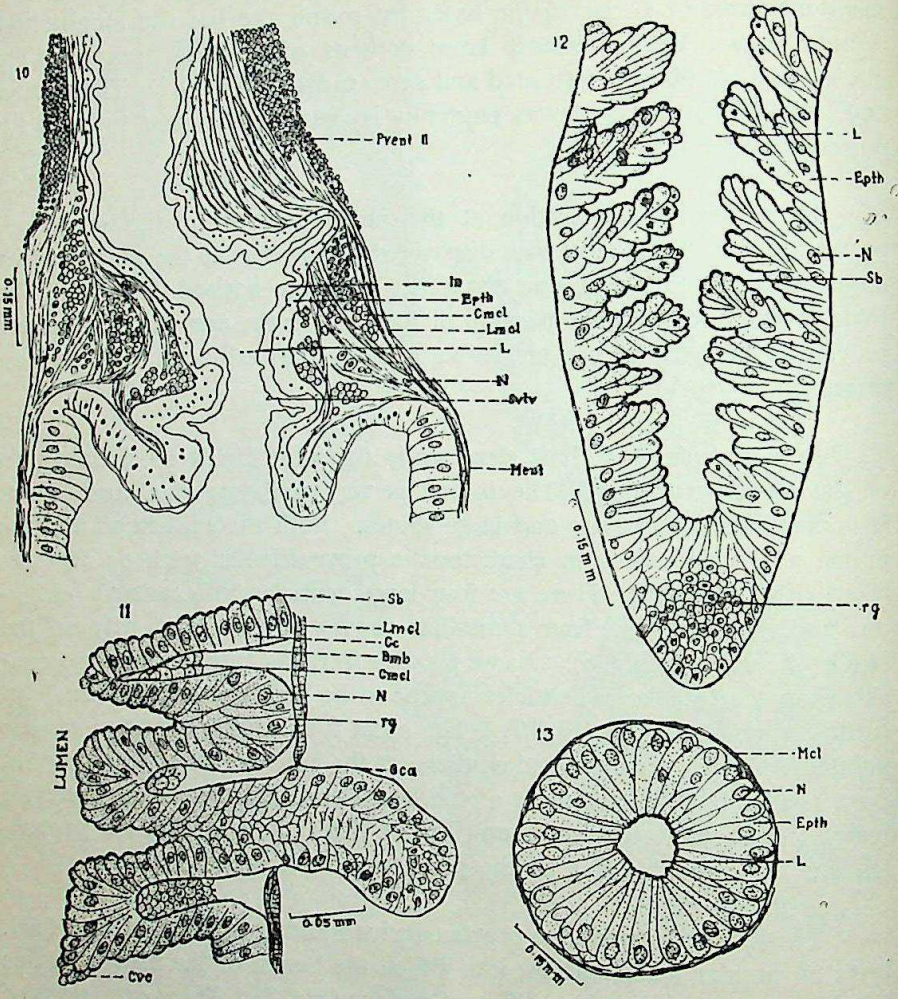
Crop : The intima is thick and has a serrated margin (Sm) towards the lumen and at places the serrations are heavy (Fig. 4). The intima is followed by the syncytial epithelium which rests on a thin transparent basement membrane. Outer to the basement membrane lies the longitudinal muscle layer. The outermost layer consists of circular muscle. The circular muscle fibres are striated and show prominent nuclei. The circular and longitudinal muscle layers gradually increase in thickness towards the posterior part.

In a longitudinal section at the junction between the crop and proventriculus I no valve was discovered. However at the junction two large cuticular folds (Cf), one above the other are noticed (Fig. 5). The folds probably control the passage of food from the crop to the anterior proventriculus. As in proventriculus I, these folds are beset with pointed spines.

Proventriculus I : It is structurally the most highly specialized part of the alimentary canal. The intima is very well-developed and hard. It is provided with strong and large spines. Both the epithelium and the intima are folded to form characteristic proventricular teeth or denticles (Dnt) (Figs. 6 and 7). There are four large denticles with concave chitinous cutting edges, and four somewhat convex edges one in between the two large denticles (Fig. 6). As we proceed from the anterior to the posterior region the four large denticles appear to be highly enlarged with sharp cutting edges at the tip (Fig. 7). The other four convex denticles become pointed with two small pointed denticles at the base one on either side of it. As a result of the enlargement of the denticles the lumen of the posterior region is reduced to the minimum (Fig. 7). This adjustment in the proventriculus I is probably due to the predatory habit of the insect.

The juction between the proventriculus I and II is bounded by a thick layer of circular muscle fibres, into which the lumen of the proventriculus I is slightly extended at four different regions (Fig. 8). These extensions of the lumen are bounded by intima and epithelium.

Proventriculus II : The intima in proventriculus II is poorly developed. Outer to the intima is present a syncytial layer of epithelium. The initima and epithelium are folded to form four large and two small folds. The folds are filled with longitudinal muscle fibres. In addition to the folds, the area all around the base of the folds are also provided with longitudinal muscles which form a continuous layer. Some large naked nuclei are seen in the longitudinal muscle layer. The circular muscles are striated, compactly arranged with prominent nuclei (Fig. 9).



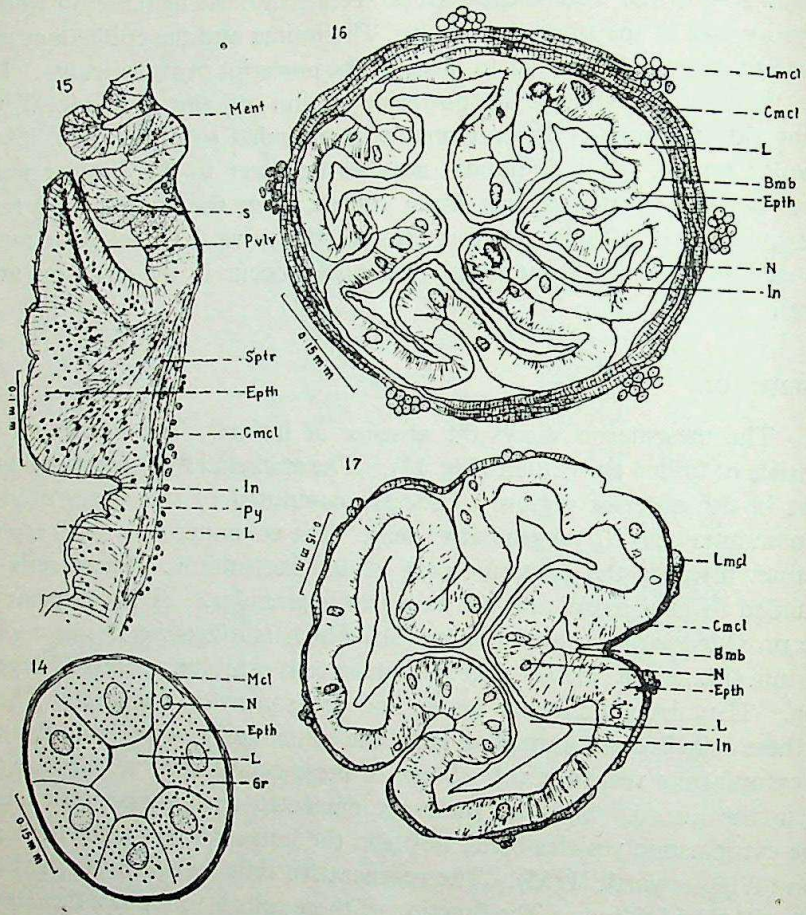
Figs. 10—13. *Cybister limbatus* Fabr., 10—L. S. proventriculus II and mesenteron showing stomodaeal valve, 11—L. S. a portion of mesenteron, 12—L.S. gastric caeca, 13—T. S. gastric caeca.

A longitudinal section (Fig. 10) of the junction region between the stomodaeum and mesenteron shows the presence of a valve—the stomodaeal valve (Svlv) guarding the opening between the two. It is formed by larger circular fold of the stomodaeal wall projecting into the mesenteron from the posterior end of the stomodaeal valve. The intima and the epithelium of this valve are structurally similar to those of the posterior proventriculus. However, the epithelial cells at the posterior region of the stomodaeal valve facing the mesenteron are columnar with rounded to oval nuclei. At the valvular region, the longitudinal muscles lie outer to the circular muscle. Some oblique striated muscle fibres radiate from the longitudinal muscle layer and traverse through the interior of the valve. The circular muscles are well-developed. Some large, oval nuclei occur in the circular muscle fibres.

MESENTERON

The mesenteron shows the absence of intima. The innermost layer consists of folded epithelium (Fig. 11). The epithelial folds are more prominent in the anterior region. They are composed of two types of cells : (*i*) columnar cells, (*ii*) regenerative cells. The columnar cells (Cc) are more distinct towards the posterior part of the mesenteron. These cells have rounded to oval nuclei and the ctoplasm is granular. The columnar cells are provided with striated border (Sb) which is otherwise known as rhabdorium (Patterson, 1937). The innermost cells exhibit a process of degeneration. They have indistinct nuclei and are somewhat vacuolar. The tips of these cells become nipped off from the epithelium and pass into the lumen of cytoplasmic vesicle (Cvc). Some of these cytoplasmic vesicles are noticed in the lumen. Some of these are nucleated and others non-nucleated. The cytoplasmic vesicles break down in the lumen to give away their secretion (Wigglesworth, 1965). The regenerative cells (rg) occur at the base of the epithelial foldings. The function of these cells is to replace the degenerative cells by their active division (Snodgrass, 1935). The epithelium rests upon a thick layer of basement membrane which consists of connective tissue as seen in *Dytiscus* (Deegener, 1910; Rungius, 1911 and Korschelt, 1924). The muscle layers are very weak and consist of inner circular muscle and outer longitudinal muscle. The peritrophic membrane is absent here.

Gastric caeca : The gastric caeca consists of a folded epithelium which is continuous with that of the mesenteron and is externally bounded by a muscular coat (Figs. 12 and 13). The epithelium consists of columnar and regenerative cells. The columnar cells have striated border towards the lumen. The nuclei are oval to rounded and prominent at the basal portion of the epithelium. The epithelium also shows process of



Figs. 14—17. *Cybister limbatus* Fabr., 14—T. S. malpighian tubule, 15—L. S. pylorus showing pyloric valve (one side only), 16—T. S. anterior ileum, 17—T. S. posterior ileum.

degeneration. At the tip of the gastric caecum large number of regenerative cells are noticed. In the lumen, at places, secretions are visible.

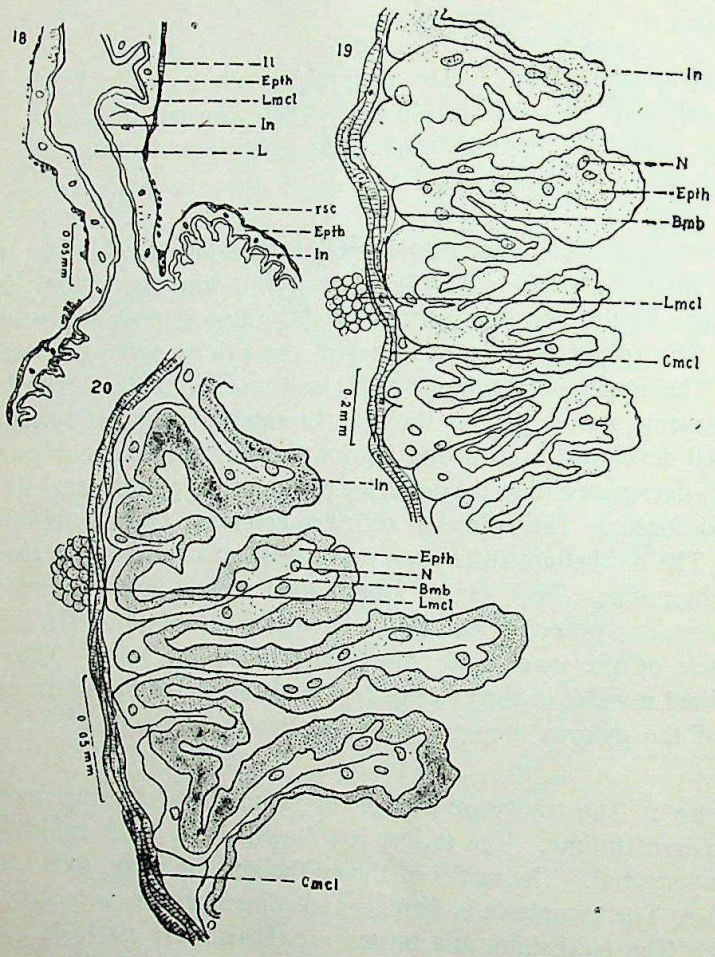
PROCTODAEUM

Malpighian tubules : The malpighian tubules consist of a single layer of cells enclosing a central lumen. The cytoplasm of the cell contains numerous prominent granules (Gr). The epithelium is externally bounded by a muscular coat (Fig. 14).

Pylorus : The longitudinal section passing through the pylorus shows a distinct pyloric valve (Pvlv) projecting into the lumen (Fig. 15). The intima in the anterior portion of this valve is provided with small spines. The sphincter muscles (Sptr) of the pyloric valve are well- developed. The malpighian tubules open just anterior to the pyloric valve. The transverse section passing through the anterior region of pylorus shows many well developed folds projecting into lumen. But the number of folds gradually decreases and at the posterior region of the pylorus only six prominent folds occur. The epithelial cells are columnar and narrow with oval nuclei. The epithelium rests upon an investment of connective tissue with prominent nuclei. Two sets of longitudinal muscle layers are marked in the pylorus, one on either side of the circular muscle layer. The longitudinal muscle of the inner side only occurs inside the folds. The external longitudinal muscles in the anterior region are scattered but in the posterior region of the pylorus they are arranged in six groups.

Ileum : The transverse section of ileum shows an innermost layer of transparent intima. The intima is followed by a thick epithelial layer which is syncytial. The nuclei of the epithelium are large, oval and fewer in number. The cytoplasm is fibrillar and sometimes few vacuoles are visible in it. The epithelium and intima are thrown into six folds anteriorly (Fig. 16) and three folds posteriorly (Fig. 17). The folds of the posterior part of the ileum are very large and almost fill the entire lumen. The basement membrane is thin but distinct. The muscle layer consists of outer longitudinal and inner circular muscles. The circular muscles in the anterior part consist of two to three layers of fibres. At the posterior part, it consists of a discontinuous layer of single muscle fibre. The longitudinal muscles are arranged in six patches. The longitudinal section passing through ileum and rectal sac shows the absence of valve at the opening of the former into the latter (Fig. 18).

Rectal sac : It consists of the innermost transparent intimal layer which is followed by the syncytial epithelium. The nuclei of the epithelium



Figs. 18—20. *Cybister limbatus* Fabr., 18—L. S. ileum and rectal sac, 19—T. S. rectal sac, 20—T. S. rectum.

are rounded to oval and are few in number. The intima and epithelium are thrown into numerous closely arranged folds projecting into the lumen (Fig. 19). The basement membrane is thin and indistinct. The musculature consists of internal circular muscles, almost single layered and external longitudinal muscles arranged in six bundles.

Caecum : The histology of the caecum resembles closely with that of the rectal sac. However, the gut wall is thinner and the folds are not so closely arranged as in the rectal sac.

Caecal appendix : Here the lumen is totally absent and the intima fills the entire lumen. The epithelium is indistinct and few nuclei are present. The musculature is poorly developed and it consists of inner circular muscle layer and outer longitudinal muscles arranged in six groups.

Rectum : The histological structure of the rectum closely resembles that of the rectal sac except that the folds are large, distinctly developed and fewer in number in comparison to that of the rectal sac. Amongst the rectal folds, one is very large in size and almost reaches the folds of other side (Fig. 20). The basement membrane is distinct. The muscle layer is comparatively thicker than the rectal sac and it consists of an inner circular muscle layer and outer longitudinal muscles arranged in six patches.

DISCUSSION

Recently Devi (1972) has described the morphology and histology of the alimentary canal and its associated organs of the phytophagous beetle, *Aspidomorpha miliaris* Fabr. (Chrysomelidae). She observed the presence of two pairs of glands opening at the anterior end of the crop, and the absence of proventriculus, gastric caeca and rectal caecum. But in *C. limbatus* which is predatory, the authors noticed the presence of proventriculus, gastric caeca and rectal caecum. The peritrophic membrane which is present in *A. miliaris* is absent in *C. limbatus*.

The authors observed the presence of a long ileum, a well-developed caecum with a tubular appendix, ventricular epithelium invested in a thick supporting layer of connective tissue and regenerative cells at the tip of the diverticulum in *C. limbatus*. Similar observations were made on *Dytiscus* by Imms (1957), Deegener (1910), Rungius (1911) and Korschelt (1924).

Landis (1936) in *Ceratomegilla fuscilabris* (Muls.) (Coccinellidae), Verma (1970) in *Opatroides punctulatus* Brull. (Tenebrionidae) and Devi (1972) in *A. miliaris* recorded the presence of six malpighian tubules covered by a facial envelope over the colon. In *C. limbatus* the facial envelope is absent and there are only four malpighian tubules.

C. limbatus resembles the beetle, *Passalus cornutus* Fabr. (Passalidae) described by Patterson (1937) in having four malpighian tubules, numerous gastric caeca and six folds in the posterior region of pylorus, projecting into the lumen.

In general, the muscularis of proctodaeum includes internal circular fibres and external longitudinal fibres. Snodgrass (1935) states that additional muscles may be present either outside or inside the ususal layers. In *P. cornutus* the muscularis of the gut consists of outer longitudinal and inner circular muscles throughout the system (Patterson, 1937). In foregut two longitudinal muscle layers occur, one outer to and the other internal to circular fibres. The longitudinal muscles of pylorus and small intestine are arranged in six bundles. In *C. fuscilabris* the longitudinal muscles of mid-intestine divide on reaching the ileum, partly continuing posteriorly outside the circular muscle and the remainder passing between the circular muscle and epithelium (Landis, 1936). Thus it appears that the muscle layers of the alimentary canal are different in different species of insects. In *C. limbatus* the longitudinal muscles lie inner to the circular muscle in the stomodaeum, while in mesenteron and proctodaeum, the circular muscles lie inner to the longtudinal muscles. The longitudinal muscles in proctodaeum are arranged in six bundles. In pylorus, two sets of longitudinal muscles occur, one on either side of the circular muscles.

In *C. limbatus* the authors did not notice the salivary glands. Snodgrass (1935) records that in general salivary glands are absent in Coleoptera. Snodgrass (1935) mentions the presence of anal glands and peritrophic membrane in many Coleoptera. In *C. limbatus* the authors failed to notice the anal glands and peritrophic membrane.

Dytiscus and *Cybister* belong to the family Dytiscidae. Both are aquatic and predatory. Our findings show that the morphology and histology of the alimentary system of both the genera are remarkably similar due to the similarty in their habiatat and manner of feeding.

SUMMARY

The morphology and histology of the alimentary canal of *Cybister limbatus* have been studied.

Morphology : The alimentary canal is distinguishable into three distinct regions *viz*., foregut, midgut and hindgut. The foregut is differentiated into pharynx, oesophagus, crop and proventriculus. The midgut is covered with numerous small gastric caeca. The four malpighian tubules arise at the junction of midgut and hindgut. The hindgut is distinguishable into the anterior intestine and the posterior intestine. The anterior intestine is represented by ileum. Pylorus is very small and lies in between ileum and midgut. The posterior intestine is represented by the rectal sac, caecum and rectum proper.

Histology : Histologically the alimentary canal consists of the enteric epithelium resting upon a basement membrane and invested externally by a muscular coat. The epithelium in the region of stomodaeum and proctodaeum is lined internally by the intima. The intima is well-developed in the stomodaeal region. The muscular coat consists of outer circular and inner longitudinal muscle in the stomodaeum. In the mesenteron and proctodaeum, longitudinal muscles occur external to circular muscle. The longitudinal muscle fibres are arranged in six widely separated groups in the proctodaeum. The longitudinal muscles of pylorus occur both external and internal to the circular muscles.

The passage between the stomodaeum and mesenteron is guarded by the stomodaeal valve. A pyloric valve guards the opening between the mesenteron and the proctodaeum.

The malpighian tubules consists of a single layer of cells enclosing a central lumen. The cytoplasm of the cells is granular.

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Key to lettering

An—Anus
Bmb—Basement membrane
Buc—Buccal cavity
C—Caecum
Ca—Caecal appendix
Cc—Columnar cells
Cf—Cuticular fold
Cmcl—Circular muscles
Cr—Crop
Dmcl—Dialaror muscles
Dnt—Denticles
Epth—Epithelium
Gca—Gastric caeca
Gr—Granule
Il—Ilium
In—Intima
L—Lumen
Lmcl—Longitudinal muscles
Mal—Malpighain tubule
Mcl—Muscles
Ment—Mesenteron
Mth—Mouth
N—Nucleus
Oe—Oesophagus
Phy—Pharynx
Pvent I—Proventriculus I
Pvent II—Proventriculus II
Pvlv—Pyloric valve
Py—Pylorus
Rect—Rectum
rg—Regenerative cells
rsc—Rectal sac
S—Spine
Sb—Striated border
Sm—Serrated margin
Sptr—Sphincter muscles
Svlv—Stomodaeal valve

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AGROCLIMATIC ZONES AND POTENTIAL EVAPOTRANSPIRATION IN ORISSA

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ABSTRACT

On the basis of precipitation temperature and potential evapotranspiration and rain factor, Orissa State has been classified into different moisture and temperature belts. The State lies in the arid humid boundary. Most of the districts lie in moisture and temperature belt of slightly dry and hot zone. Koraput lies in moist and mild cold zone. The potential evapotranspiration is the least during the month of January and maximum in the month of May. Evaporation from the open pan, though less than the PET value follows the same pattern. The need for irrigation *vis-a-vis* moisture conservation is the maximum during the months of February to April. The period from August to October needs drainage. The average potential evapotranspiration of the state is 182 cm.

INTRODUCTION

Climate of a place is classified to identify and show relationship between climatic parameters, soil, plant and interdependent agricultural operations. Several attempts have been made in the past using rainfall, temperature, evaporation, sunshine hours etc., to classify climate and to show relationship between the environment and Agriculture (Transoau, 1905 ; Lang, 1920 ; Thornthwaite, 1948). Thornthwaite introduced the term potential ovapotranspiration to express the combined effect of evaporation and transpiration occurring from soil and plant and calculated empirically from climatic data. Gorczinski (1943) used latitude, annual precipitation in the wettest and driest year to calculate ardity index. Paramanik (1952) proved precipitation and evaporation ratio to be a better aridity index as evaporation is proportioned to day length and temperature and inversely to relative humidity. Krishnan and Singh (1968) used moisture index and mean annual temperature to classify agroclimatic zones. These calculations provide base for calculating water requirement and irrigation requirement of crops for long period basis.

METHODS

The state of Orissa lies in sub-tropical belt between 17°-31′ and 22°-82′ N lat. and 81°-31′ and 87°-37′E long. The average annual rainfall of the

state is 1498 mm. with 78 rainy days of which 1,220 mm is received during the period from June to September. August is the rainiest month and December and January are the driest months. Distribution of rainfall is uneven and unreliable. Rainfall pattern controls all agricultural operations. While some part of the state suffers from drought other part suffers from flood. Aridity index, rain factor, moisture index and potential evapotranspiration for different districts of Orissa have been calculated. Rainfall from 117 centres in 13 districts recorded from 1901 to 1968 as supplied by the meteorologicol office, Poona, and collected by the author (not less than 35 years data for any centre) have been taken into account. Weekly rainfall for different districts have been calculated. From open pan evaporation at Bhubaneswar, Cuttack and Chakuli, weekly evaporation to represent atmospheric demand have also been calculated. The formulae used are as follows :

1. Rein factor $= \frac{\text{average rainfall (mm)}}{\text{average annual temp. (} \quad ^\circ C)}$

2. Moisture index

$$\frac{P-PET}{PET} \times 100$$ where,

P = mean annual precipitation

PET = potential evapotranspiration as computed by Thornthwaite method.

3. $PET = 1{\cdot}6\left(\frac{10t}{I}\right)^a$

t = mean monthly temp. in (°C)

I = heat index; $I = \frac{12}{I} i$, $i = \left(\frac{t}{5}\right)^{1{\cdot}514}$

a = $0{\cdot}000,000,6751^3 - 0{\cdot}000077112 + 0{\cdot}17921 + 0{\cdot}49239$

PET is adjusted taking number of days of the month and day into consideration.

Table 1

Rain factor, moisture index, mean temperature and moisture temperature belt of Orissa and agrocliomatic zones of Orissa.

Zone and District	Rain factor	Moisture Index : P (cm)	PET (cm)	P-P PET/ 100	Mean Annual Tempera-ture °C	Moisture and Temperatu-re belt
Northern Platean						
Mayurbhanj	60·8	163·6	201·5	—18·8	26·9	Slightly moist hot
Keonjhar	63·3	153·2	140·2	+ 9·7	24·2	Moist hot
Sundargarh	60·4	164·7	208·43	—20·9	27·3	Slightly dry and hot
Central Table land						
Sambalpur	57·6	154·9	201·9	—23·2	26·9	Slightly dry and hot
Bolangir	50·8	141·8	234·7	—39·6	27·9	Slightly dry and hot
Dhenkanal	54·8	143·9	189·7	—23·1	26·6	Slightly dry and hot
Eastern ghat region						
Koraput	65·9	152·2	121·1	+25·6	22·5	Moist and mild cold
Phulbani	64·3	158·8	148·1	+ 6·88	24·6	Moist and mild hot
Kalahandi	53·0	137·4	159·2	—13·7	25·9	Slightly moist hot
Coastal Tract						
Cuttack	55·2	153·4	212·2	—27·7	27·8	Slightly dry and hot
Puri	53·4	144·8	192·5	—24·8	27·1	Slightly dry and hot
Balasore	60·8	161·7	186·2	—13·2	26·6	Slightly moist and hot
Ganjam	48·1	128·8	171·3	—24·8	26·3	Slightly medium, dry and hot

Table 2

Average weekly rainfall and evaporation in Orissa (mm)

Week	1	2	3	4	5	6	7	8	9	10
Rainfall (mm)	6·5	7·4	0·3	0·4	1·1	0·8	2·9	9·6	23·3	1·9
Evaporation (mm) Chakuli	17·8	17·5	19·5	20·2	22·2	31·1	31·9	33·9	30·7	31·0
Bhubaneswar	20·6	21·2	22·9	24·4	29·0	32·6	34·9	37·8	40·7	45·9
Cuttack	20.0	12·6	16·8	21·8	25·4	28·8	28·0	38·9	35·1	39·9
Mean	19·5	17·1	19·7	22·1	25·5	30·8	31·6	35·9	35·5	38·9

Week	11	12	13	14	15	16	17	18	19	20
Rainfall (mm)	0·5	4·8	3·6	10·2	4·3	5·2	13·1	22·8	15·0	11·8
Evaporation (mm) Chakuli	30·2	38·9	37·9	36·8	42·7	44·2	47·2	44·7	51·2	54·3
Bhubaneswar	45·8	46·0	49·3	51·5	60·9	64·3	64·4	64·7	68·3	72·5
Cuttack	33·3	32·2	37·5	48·7	48·4	45·7	34·6	49·6	57·3	54·0
Mean	36·4	39·0	41·6	45·7	50·7	50·4	48·7	53·0	58·9	60·3

Week	21	22	23	24	25	26	27	28	29	30
Rainfall (mm)	14·7	6·3	40·1	49·8	60·0	79·2	63·5	56·2	106·1	88·5
Evaporation (mm) Chakuli	55·6	60·9	57·8	56·2	41·7	23·6	29·4	35·1	21·6	23·1
Bhubaneswar	69·9	67·7	66·8	50·2	36·6	27·1	26·0	28·6	23·5	22·1
Cuttack	55·1	58·5	64·0	38·3	23·8	23·0	28·1	34·1	25·3	16·3
Mean	60·2	62·4	62·9	48·2	34·0	24·6	27·8	32·6	23·5	20·5

Week	31	32	33	34	35	36	37	38	39	40
Rainfall (mm)	146·4	66·9	101·8	57·8	41·6	71·7	66·2	59·7	26·7	34·1
Evaporation (mm)										
Chakuli	9·2	20·6	19·8	25·5	28·3	28·2	25·5	26·4	29·5	23·8
Bhubaneswar	21·6	25·9	26·5	21·9	29·5	26·3	15·9	27·1	26·7	26·3
Cuttack	8·3	21·5	21·4	24·5	23·5	23·9	15·5	28·1	21·7	27·2
Mean	16·4	22·7	22·6	24·0	27·1	26·1	19·0	27·2	26·0	25·8

Week	41	42	43	44	45	46	47	48	49	50
Rainfall (mm)	38·7	18·0	23·9	2·8	13·7	6·2	10·6	2·1	3·5	0·3
Evaporation (mm)										
Chakuli	24·3	23·1	27·3	22·4	21·7	20·8	21·5	21·8	20·5	18·0
Bhubaneswar	23·1	20·8	26·9	24·4	24·1	20·8	20·5	22·3	24·5	23·9
Cuttack	19·2	22·9	28·0	25·9	24·9	22·2	16·9	23·1	22·7	20·0
Mean	22·2	22·3	27·1	24·2	23·6	21·3	19·6	22·4	22·6	20·6

Week		51	52
Rainfall (mm)	...	1·9	2·3
Evaporation (mm)			
Chakuli	...	17·0	18·7
Bhubaneswar	...	22·9	24·4
Cuttack	...	20·9	23·9
Mean	...	20·3	22·3

Table 3

Estimated Potential evapotranspiration and evaporation of different districts of Orissa (cm.) by Thornthwaite method

Districts Months	Mayur-bhanj	Keon-jhar	Dhen-kanal	Bolan-gir	Sambal-pur	Kora-put	Phul-bani	Bala-sore	Cuttack	Puri	Ganjam	Kala-handi	Sundar-garh	Mean	Pan Evaportia(cm.)
January	3·95	3·68	4·40	5·34	4·41	4·86	3·85	4·48	5·71	5·67	6·17	5·62	3·13	4·71	8·4
February	7·56	6·26	8·72	9·94	7·29	6·61	6·01	7·88	9·57	9·56	8·46	9·51	6·94	8·03	12·0
March	16·51	13·03	16·17	19·50	13·38	11·39	11·17	15·11	16·80	15·69	12·99	18·70	16·37	15·14	19·8
April	26·60	17·42	24·39	32·53	25·60	15·32	18·52	21·97	24·22	21·69	16·28	18·10	25·48	22·16	21·8
May	34·69	20·42	32·61	47·05	32·32	18·57	25·17	27·65	31·95	28·36	21·56	19·84	38·35	29·50	19·9
June	28·37	19·20	25·79	32·60	31·30	14·92	20·45	24·94	25·93	24·81	20·99	23·74	31·14	24·70	15·8
July	21·30	13·37	19·43	20·63	20·16	11·25	15·63	20·10	22·18	18·91	18·63	13·66	22·91	18·32	10·0
August	19·74	16·54	17·43	18·34	17·90	9·85	13·99	19·15	20·25	18·94	18·70	15·57	19·44	17·29	9·8
September	17·89	12·60	16·01	20·20	17·79	9·60	13·33	17·60	19·56	17·65	17·34	14·84	18·60	16·38	10·2
October	12·80	10·14	12·89	15·29	14·19	8·87	10·03	14·07	17·57	15·45	14·29	10·90	14·43	13·14	9·1
November	7·70	5·91	7·93	8·80	8·82	5·51	6·21	8·57	11·46	10·03	9·43	5·43	7·39	7·93	9·2
December	4·23	3·66	3·96	4·50	4·40	4·33	3·74	4·72	7·06	5·72	6·49	3·62	3·75	4·62	9·0
TOTAL	201·54	140·23	189·73	234·72	201·92	121·08	148·10	186·26	212·26	192·48	171·33	159·28	208·43	182·12	

RESULTS

Data on rain factor, moisture index, mean annual temperature and agro-claimatic zone are presented in Table 1 and Fig. 2. Rain factor varies from 48 to 64 and accordingly all the districts fall in the range above arid and lower humid zone. Except for the districts of Keonjhar, Koraput and Phulbani the moisture index of other districts varies from —13 to —40. For former three districts the moisture index varies from +6 to +22. The moisture and temperature belt of Mayurbhanj and Balasore is slightly moist and hot, that of Sundergarh, Sambalpur, Bolangir, Dhenkanal, Cuttack, Puri and Ganjam districts is slightly dry and hot. Keonjhar is moist and hot and Koraput is moist and mild cold. Phulbani district is moist and mild hot. To support these data moisture content in different parts of the districts during different months of the year need be determined and calculated on the basis of available moisture. Depending on percentage of available moisture the success of multiple cropping particularly under rainfed conditions is to be determined.

Aridity index

The aridity index for Bhubaneswar calculates to 0·92 and 0·96 respectively by the methods of Gerczinski (1942) and Paramanik (1952) and supports the statement that the state lies in arid-humid boundary.

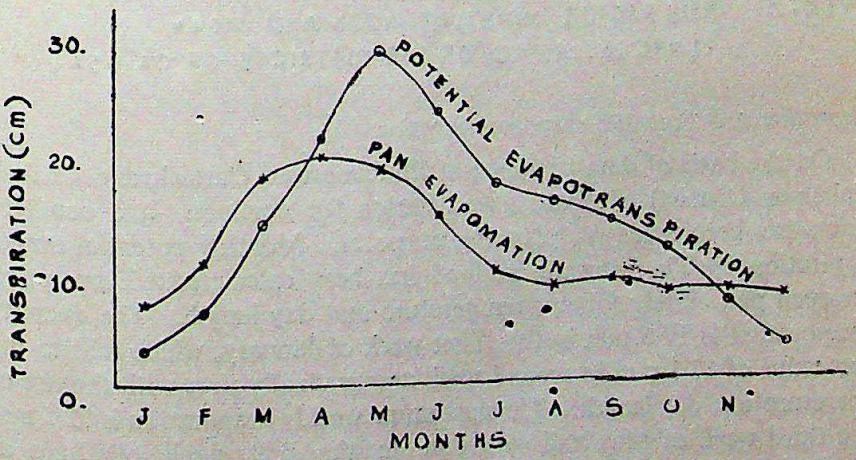

Fig-1 AVERAGE POTENTIAL EVAPOTRANSPIRATION AND PAN EVAPORATION IN ORISSA.

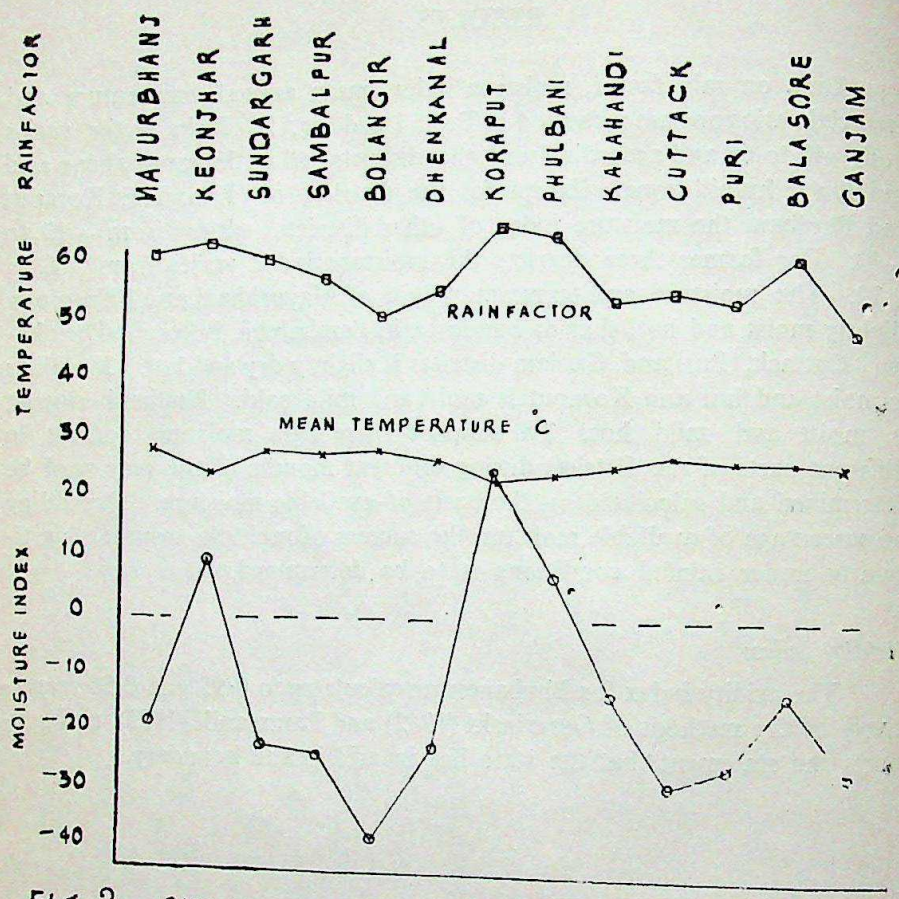

Fig-2 RAIN FACTOR, MOISTURE INDEX AND MEAN TEMPERATURE °C OF THE DISTRICTS OF ORISSA

Evaporation and Potential-evapotranspiration

On the basis of data obtained at Bhubaneswar, Cuttack and Chakuli (Sambalpur District) a broad generalization for northern and southern districts has been made for planning purposes. Monthly potential evapotranspiration by Thornthwaite method has been calculated. Evaporation from open pan closely follows temperature and day length. The quantity of evaporation is 19·5 mm in the first week of January, which falls to the lowest value of 17·1 mm in second week and gradually rises with the rise of temperature and day length. The maximum weekly evaporation is 72·5 mm in the third week of May and 60·9 mm in the first week of June at Chakuli (Table 2). The total annual evaporation for the state is 1,663 mm. P/E ratio of the state is 0.84. The potential evapotranspiration is 182·12 cm and is higher than open pan evaporation (Tables 2 and 3, Fig. 1).

On the basis of weekly rainfall and evaporation data, time indicating need for irrigation/drainage has been pointed out. These data need be further standardized in respect to moisture requirement and deficit. Moisture deficit in rainfed areas under system of multiple cropping has been worked out (Lenka, 1973).

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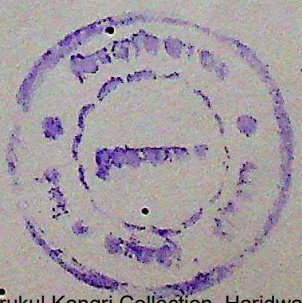

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BOUNDARY LAYER FLOW OF A NON-NEWTONIAN FLUID ALONG THE OUTSIDE OF A THIN LONG POROUS CIRCULAR CYLINDER

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ABSTRACT

The study of the boundary layer flow along the outside of a long thin porous cylinder has been extended to a Reiner-Rivlin fluid model. It is seen that the boundary layer characteristics are not influenced by the non-Newtonian Parameter in the case of a non-Porous cylinder.

INTRODUCTION

The problem of boundary layer flow along the outside of a long thin circular cylinder was studied by Glauert and Lighthill (1955). The present discussion relates to the influence of porosity of the cylinder on the boundary layer flow characteristics of a Reiner-Rivlin fluid. The results obtained here agree well with the earlier results obtained in respect of a Newtonian fluid when both the non-Newtonian parameter and the suction parameter vanish.

Equations of motion

Representing the radial, azimuthal and axial components of the fluid velocity by w, v and u respectively in cylindrical polar co-ordinates (r, Θ, x) for the cylinder $0 < r \leqslant a$, the appropriate boundary layer equations for the u-direction together with the boundary conditions are :

$$wu_x + uu_x = \gamma \left(u_{rr} + \frac{u_r}{r} \right) - \frac{2\gamma_0}{r} (wu_{rr} + u_r w_r) \qquad (1)$$

$$u_x + w_r + \frac{w}{r} = 0. \qquad (2)$$

$$u = 0, \qquad w = \frac{A}{r} \; : \; r = a$$

$$u = u_0, \qquad w = 0 \; ; \; r \to \infty \qquad (3)$$

where the suffixes denote partial differentiation with respect to them, γ, γ_c are the coefficients of kinematic viscosity and cross viscosity, A the parameter characterising suction and u_0 the velocity of the fluid in the frictionless flow.

Following Glauert and Lighthill we obtain from (1), (2) and (3)

$$(\gamma-\lambda)\, u_{zz} + \frac{1}{a}(\gamma - A + \lambda)\, u_z = 0 \qquad (4)$$

$$(\gamma-\lambda)\, u_{zzz} + \frac{1}{a}(\gamma - A + 3\lambda)\, u_{zz} - \frac{1}{a^2}(\gamma - A + 3\lambda)\, u_z = 0 \qquad (5)$$

$$z = 0$$

where $\lambda = 2\gamma_c A/a^2$

SOLUTION : Assuming a solution of (4) and (5) as

$$u = \frac{u_0}{\alpha}\log\left(\frac{1+\xi z/a}{1+\eta z/a}\right) \qquad z < a\,\frac{e^{\alpha}-1}{\xi-\eta e^{\alpha}} = \delta$$

$$= u_0 \qquad z \geqslant \delta$$

and performing the necessary integrations under the transformation $z = a(e^t - 1)/(\xi - \eta e^t)$ we obtain

α (function of $\frac{\gamma x}{u_0 a^2}$ as defined by [1])

$$= \left(\frac{z}{l}\right)^{\frac{1}{2}} - \frac{m}{6l}\left(\frac{z}{l}\right) + \frac{50m^2 - 9nl}{720l^2}\left(\frac{z}{l}\right)^{3/2} - \ldots\ldots$$

(D) (Drag coefficient) $= \int_0^{\delta} 2\pi a\,(\mu\, u_z)_0\, dz$

$$= \frac{2\pi a^2 u_0^2 \rho}{\alpha^2}\Big[\, P\left\{(\alpha-2)e^{\alpha} + (\alpha+2)\right\} + Q\left\{(\alpha-1)e^{2\alpha} + (\alpha+1)\right\}$$

$$+ R\left\{(\alpha - \tfrac{2}{3})e^{3\alpha} + (\alpha + \tfrac{2}{3})\right\} + \ldots\ldots$$

Δ (Displacement area) $= 2\pi \int_0^{\infty} \left(1 - \frac{u}{u_0}\right)(a+z)\, dz$

$$= \frac{\pi a^2}{2\alpha}\left[(\xi-\eta)\left\{(\xi^2-\eta^2)(3\xi-2\xi\eta-4\xi^2+\eta)-2\xi^2(\xi+\eta-2\xi\eta)\log\left(1-\frac{\eta}{\xi}\right)\right\}\xi^{-6}\right.$$

$$+\frac{2\alpha(1-2\xi)}{\xi^2}+4(\xi-1)(\xi-\eta)\xi^{-3}e^{\alpha}+(\xi-\eta)(\xi-3\eta+2\xi\eta)\xi^{-4}e^{2\alpha}$$

$$\left.+\tfrac{4}{3}(\xi-\eta)\eta(\xi-2\eta+\xi\eta)\xi^{-5}e^{3\alpha}+\ldots\ldots\ldots\right]$$

where

$$\delta\ (\text{boundary layer thickness}) = a\,\frac{e^{\alpha}-1}{\xi-\eta e^{\alpha}}$$

$$Z = \frac{12\gamma x}{u_0 a^2}$$

$$\xi = 2^{-1}\left[(\gamma-A+\lambda)+\left\{4\gamma^2-A^2-3(\gamma-\lambda)^2\right\}^{\frac{1}{2}}\right](\gamma-\lambda)^{-1}$$

$$\eta = 2^{-1}\left[(\gamma-A+\lambda)-\left\{4\gamma^2-A^2-3(\gamma-\lambda)^2\right\}^{\frac{1}{2}}\right](\gamma-\lambda)^{-1}$$

$P = (\xi-1)\xi^{-3}$

$Q = 0.25(\xi-3\eta+2\xi\eta)\xi^{-4}$

$R = \frac{1}{3}(\xi-2\eta+\xi\eta)\eta\xi^{-5}$

$l = P + 4Q + 9R$

$m = 2(P + 8Q + 27R)$

$n = 9(P + 16Q + 81R)$

DISCUSSION

For all real values of ξ, η we have

$$-\sqrt{3}\,k-(1+4k^2)^{\frac{1}{2}} < (1+k^2)\frac{A}{\gamma} < \sqrt{3}\,k+(1+4k^2)^{\frac{1}{2}}$$

For very small values of A/γ and λ/γ so that their squares and higher powers as well as their product can be neglected we get,

$$\xi = 1 - 1.8\eta - 1.4\frac{A}{\gamma}$$

$$\eta = \frac{A}{2\gamma}\left(1+10\frac{\gamma_c}{a^2}\right)$$

If δ_o , δ denote boundary layer thickness for a Non-Newtonian fluid without suction (same as Newtonian fluid without suction) and with suction respectively then,

$$\delta_o = a\ (e^{a}-1)$$

$$\delta = a\ \frac{(e^{a}-1)}{\xi-\eta e^{a}} = a\ \frac{e^{a}-1}{1-1.8\eta-1.4\dfrac{A}{\gamma}-\eta e^{a}}$$

giving

$$\frac{\dfrac{1}{\delta}+\dfrac{5}{14a}-\dfrac{A}{2\gamma a}}{\dfrac{1}{\delta_o}+\dfrac{5}{14a}}-1=\frac{14A\gamma_o}{\gamma a^2} \qquad \text{(i)}$$

From (i) it is evident that boundary layer thickness decreases for $A > 0$ (injection) and increases for $A < 0$ (suction). The non-Newtonian parameter γ_o does not occur anywhere in the equation excepting being multiplied by A, it is obvious that the boundary layer characteristics are not influenced by the non-Newtonian character of the fluid in case of a non-porous cylinder.

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STUDIES ON THE APHIDIDAE OF INDIA-XVIII. ON THE MORPHOLOGY OF DIFFERENT INSTARS OF *APHIS CRACCIVORA* KOCH. (APHIDIDAE, HOMOPTERA)

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ABSTRACT

The nymphal morphology and biometry of *Aphis craccivora* Koch., have been studied.

INTRODUCTION

Identification of aphids are generally based on the morphology of alate and apterous viviparae. Nymphs of aphids have not been studied in detail and it is yet to be established whether the characters of the adult which separate one species from the other can as well be employed in the determination of the nymphs. It is happy to recall that Takahashi (1924) made preliminary studies of the nymphs of different aphid species recorded by him from Formosa, Japan. The present investigation deals with a detailed study of the apterous and alate nymphs of different instars of *Aphis craccivora* Koch.

MATERIALS AND METHODS

Adult apterous specimens of *A. craccivora* were collected on the bean plant, *Dolichos lablab* at Bhubaneswar, Orissa and were reared in the laboratory on fresh leaves of the same plant kept inside a pair of petridishes on water-soaked Whatman filter paper No. 1. The study was undertaken during December, 1973 to January, 1974 when the mean room temperatures were 20·3°C and 20.0°C respectively. Everyday in the morning, the old leaves were replaced by fresh ones. A fine camel-hair brush was used in transferring the aphids from the old to the new leaf. When the adult aphid gave birth to young nymphs, the latter were removed to be reared separately. Alate viviparae lay apterous nymphs under the ordinary laboratory conditions. First instar nymphs destined to form alate and apterous adults are the same in all morphological details, but they

differ in their second and subsequent nymphal instars (Behura *et al.*) and therefore second instar nymphs destined to form alatae were collected in the field and reared in the laboratory for the study of nymphal morphology. For slide preparations specimens were collected and preserved in 70% alcohol. Later they were treated in 70% lactic acid at 50°C from one to ten hours depending on size and instar. Then the specimens were thoroughly washed in distilled water and after passing through different grades of alcohol were mounted in balsam. Measurements were done with an ocular micrometer.

DESCRIPTION OF NYMPHAL STAGES

FIRST INSTAR (Same in the alatae and apterae)

Colour : When born the general body colour is glassy green, which later turns to pale green.

Body : Ovate, tapers towards both ends. Length of body from the tip of the antennal tubercle to the tip of the posterior end (cauda not developed) is 0.708-0.799 mm, and the maximum breadth of the body ranges from 0.396-0.461 mm. with a mean of 0.430 mm.

Head : Deflexed, broader than long, breadth 0.301 mm., dorsoventrally flattened and bears ten to twelve hairs 12 μ long. Antero-laterally the head is prolonged to form a pair of antennal tubercles. A dorso-lateral compound eye is present behind each tubercle (Fig. 3). Few rounded ocular facets occur towards the outer margin of the eye. A small ocular tubercle marks the postero-lateral margin of each eye. The head capsule consists of a large clypeus divisible into an ante-clypeus and a post-clypeus. Articulated to the ante-clypeus is the conical and serrated labrum. The modified outer pair of mandibular stylets and inner pair of maxillary stylets take their origin from a pair of socket-like structures situated in the ante-clypeus. The stylets are hollow, long, slender and thread-like structures with pointed tips. The maxillary stylets lie opposed to one another.

Rostrum : Four-segmented, extends upto the third coxa. First two segments are of the same diameter and are not well demarcated, third segment has its greatest diameter in the middle, and the fourth one tapers to a horny point (Fig. 2). Segment I+II 0.165, seg. III 0.065, seg. IV 0.088 and the total length of the rostrum is 0.319 mm. Total number of hairs on the rostrum is 16 and each is about 12 μ long. However, two hairs at the sub-apical portion of the fourth segment are slightly larger than the rest. A hollow canal-like structure, the rostral recess, runs dorsally through all the rostral segments. It provides space for the modified stylets. A pair of knob-like

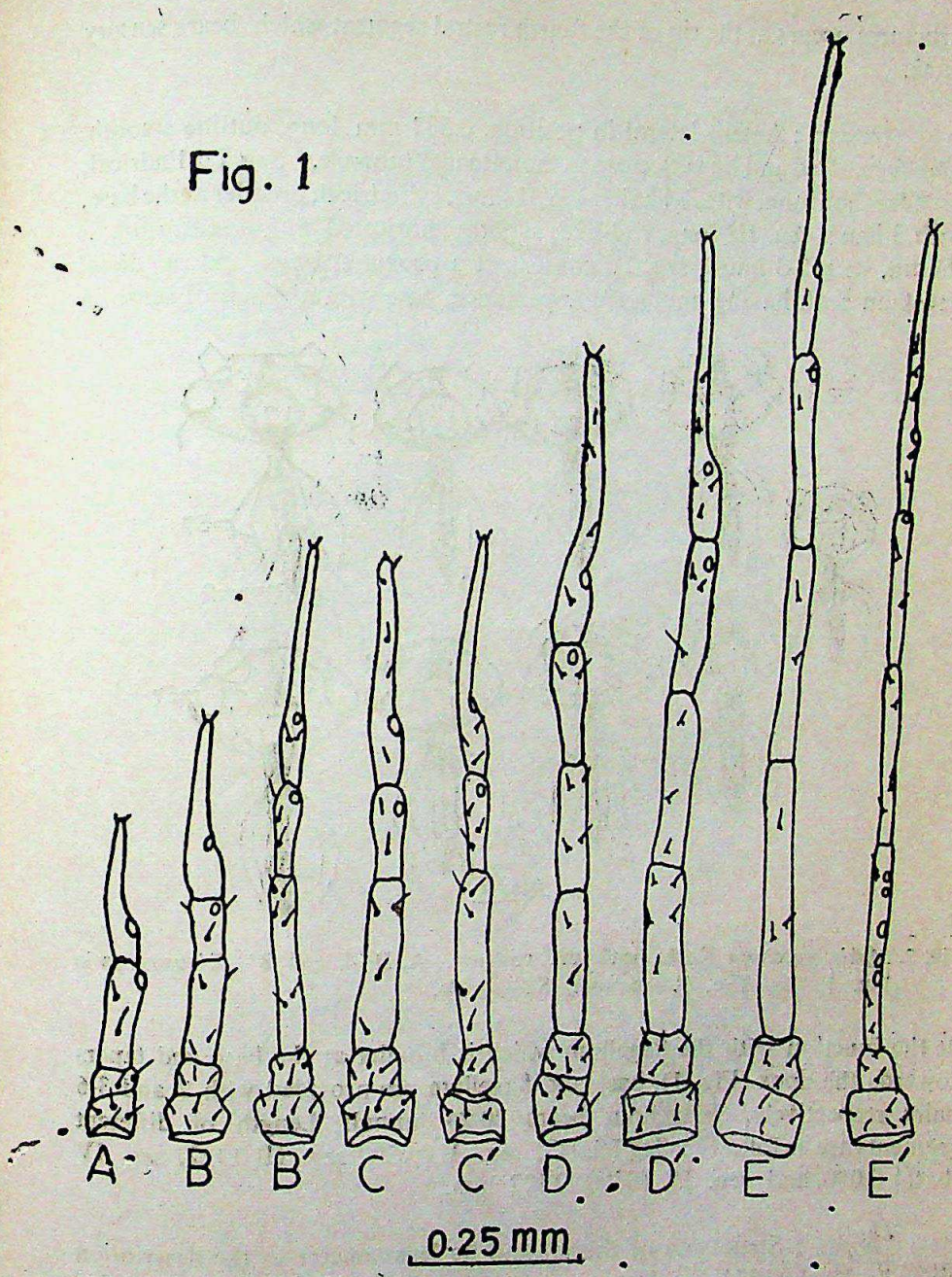

Fig. 1. *Aphis craccivora* Koch, antenna. A—first instar, B—E second to fourth instars and adult (apterae), B′ to E′—second to fourth instars and adult (alatae).

structures occurs at the tip of the fourth rostral segment which bears sensory setae.

Antenna : Antero-lateral in position, 0.383 mm long, outline smooth, four-segmented and lie very close to the antennal tubercle. Seg. I cylindrical, broader than long, with 3-4 hairs; seg. II short, cylindrical, broader at the base, with 3 hair; seg. III long, rod-like; slightly imbricated with a sensorium at the tip, with 2-3 hairs; seg. IV consists of a proximal base and a distal flagellum both having annulated appearance, base with a group of sensoria

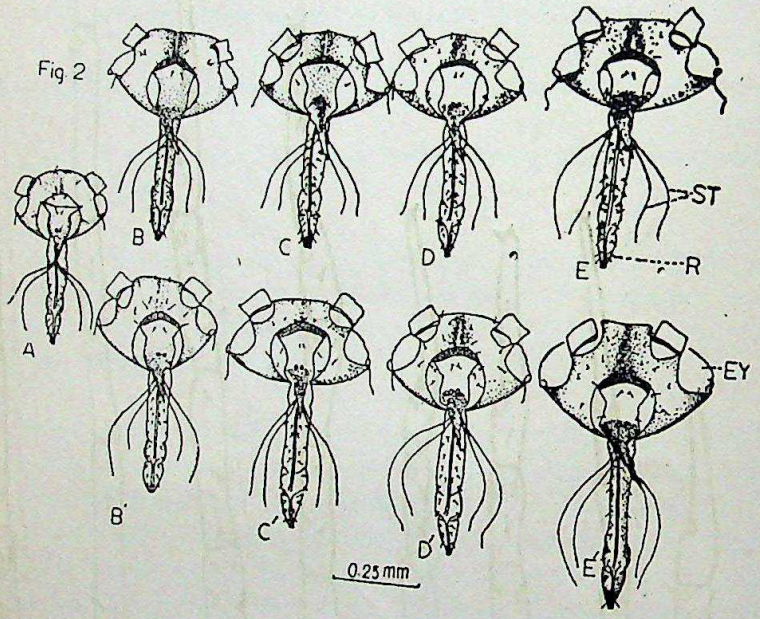

Fig. 2. *Aphis craccivora* Koch, head and rostrum. A, B—E and B′—E′ same as in Fig. 1. Ey—Eye, R—rostrum, ST— stylets.

at the junction with the flagellum which is broader at the base and tapers towards the apex (Fig. 1), base and flagellum are provided with 2 and 3-6 hairs respectively. Flagellum bears 20-24 annuli Length of different segments are as follows : Seg.I 0.048, seg. II 0.039, seg. III 0.122, seg. IV (base) 0.050 and seg. IV (flag.) 0.122 mm.

Thorax : Structures of thorax and its legs concert to the description given by Dash (1974) for *Myzus persicae* (Sulz.). However, it is interesting to note that the number of hairs on tarsus I happens to be, foreleg 2 : midleg 2 hindleg 2 (Fig. 6 A), but one specimen deviated to have foreleg 2+3 : midleg 2+3 (Fig. 6 B): hind leg 2+2 hairs (Fig. 6C). The regular set of 2 hairs is towards the tip of the segment but the additional set of 3 or 2, is proximally situated at the base. The additional three hairs are present in a row, the

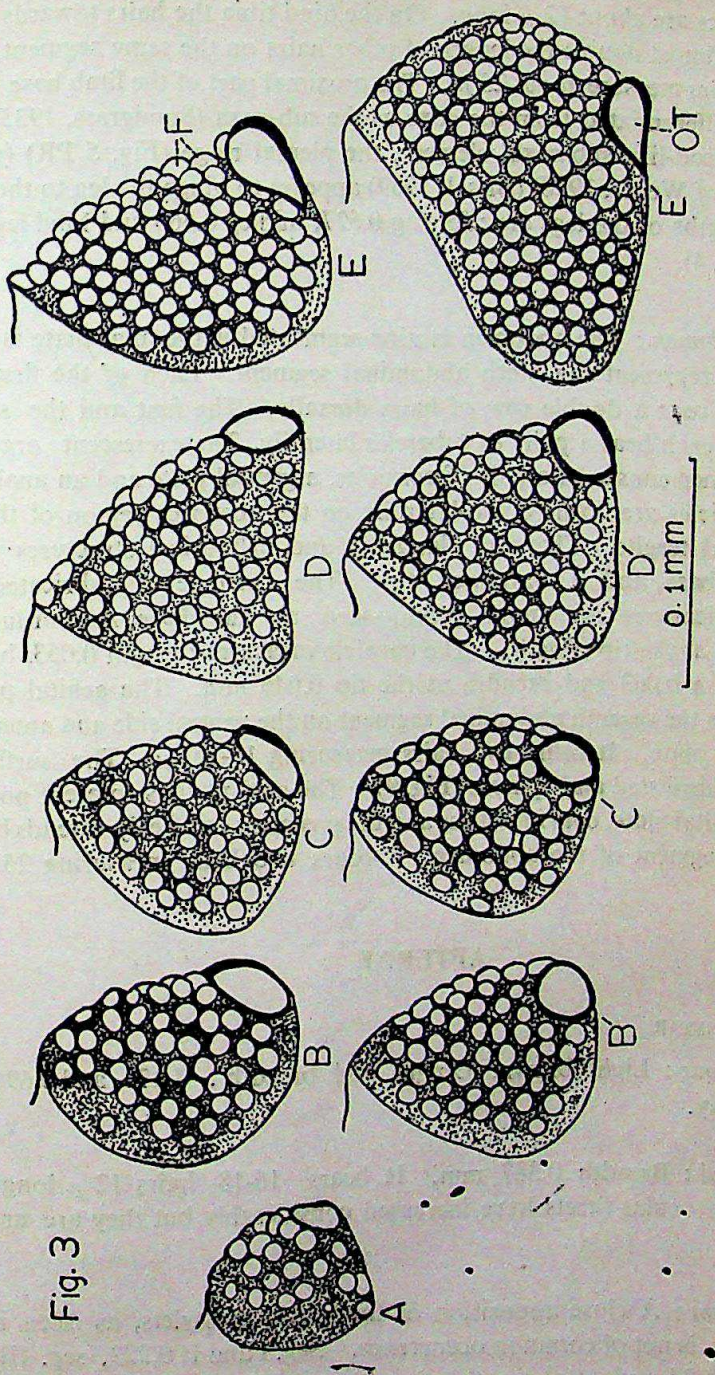

Fig. 3. *Aphis craccivora* Koch, eye. A, B—E and B′—E′ same as in Fig. 1. F—ocular facets, OT—ocular tubercle.

middle one being always smaller measuring about 8 μ in length while all the other hairs are about 12 μ long. On the hind tibia the hairs towards outer-side are almost double the length of other hairs on the same segment. The longer hairs measure about 25 μ. The proximal part of the limb base can be further differentiated from the coxa as the sub-coxa (Snodgrass, 1935). An irregular rod-like sub-coxal element, the pleural ridge (Fig. 5 PR) (pleural ligament of Weber, 1928) (Bissel, 1969) appears to hinge the leg to the body. Total lengths of the legs are : foreleg 0.527, midleg 0.560 and hind leg 0.627 mm. (Fig. 4).

Abdomen : The abdomen is nine-segmented if the anal plate is considered to represent the ninth abdominal segment. Each of the first eight segments bear a double row of hairs dorsally. The first and the seventh segments each bear a pair of tubercles laterally. The excrescent organs of the abdomen consist of a pair of cornicles, a genital plate and an anal plate. The cornicles are borne dorso-laterally on the posterior region of the fifth abdominal tergite. They are elongated and cylindrical structures with a broader base and a narrower tip. The cornicle is imbricated and the imbrications are more pronounced at the base. A semi-lunar lip is present at the tip (Fig. 8). The cornicle measures : length 0.053, breadth at the base 0.063 and breadth at the tip 0.046 mm. The genital plate is present on the seventh abdominal segment on the ventral side and anterior to the anal plate. It bears two hairs measuring 12-25 μ. The surface is slightly imbricated and spinose (Fig. 9). The anal plate is present posterior to the genital plate, oval in outline and the posterior end freely extends beyond the last segment of the abdomen. It bears two hairs measuring 25—31 μ (Fig. 10).

APTERAE

SECOND INSTAR

Colour : Light brown, Length and breadth : 1.176 and 0.696 mm. respectively.

Head : Breadth 0.387 mm. It bears 16-18 hairs 12 μ long. The number of ocular facets have increased considerably but they are arranged loosely.

Rostrum : A close apposition of the maxillary stylets, as seen in the first instar, is not of common occurrence. Seg. I and II 0.222, seg. III 0.068, seg. IV 0.094 and total length of rostrum 0.387 mm. Hair distribution : Seg. I and II 12, seg. III 4, and seg. IV 7 hairs. The hairs measure about 12 μ in length.

Fig. 5

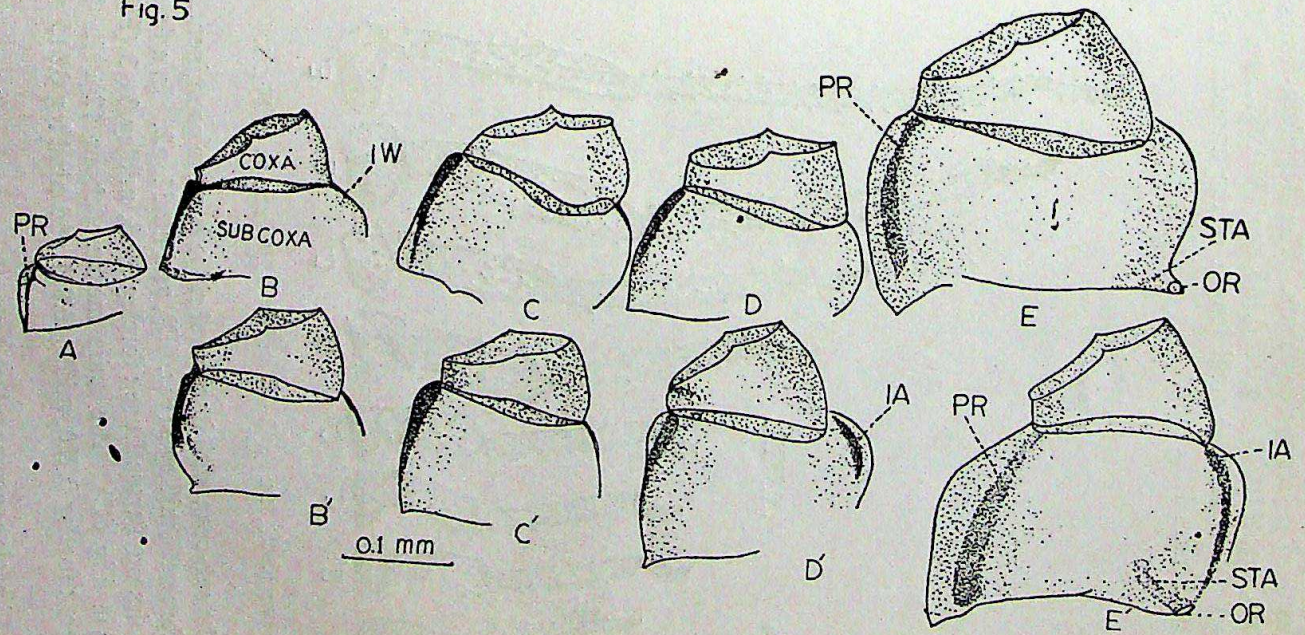

Fig. 5: *Aphis craccivora* Koch, coxa and sub-coxa. A, B—E, and B′—E′ same as in Fig. 1. IA—inner apodeme. IW—inner wall of sub-coxa, OR—orifice, PR—pleural ridge, STA—sternal apophysis.

Antenna : Antenna five-segmented, fourth segment and fifth basal segment each bears a group of primary and accessory sensoria respectively. Imbrications are noticed in all the segments. The flagellum bears 25-29 annuli. Seg. I 0.058, seg. II 0.049, seg. III 0.136, seg. IV 0.081, seg. V (base) 0.070, seg. V (flag.) 0.167 and the total length of the antenna 0.565mm. Antenna bears 19-35 hairs 12 μ long.

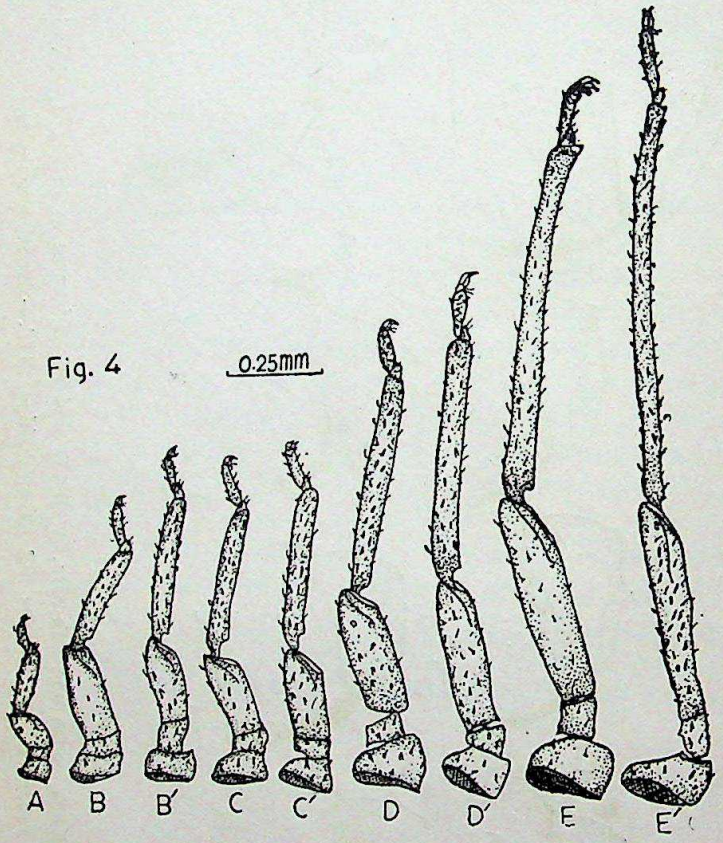

Fig. 4. *Aphis craccivora* Koch, leg. A, B—E and B′—E′ same as in Fig. 1.

Thorax : The sub-coxa with its pleural ridge is more prominent. Hairs on tarsus I are : foreleg 3, midleg 3 (Fig. 6D), and hind leg 2. In a few cases, the number of hairs on Tarsus I are : foreleg 3+3, midleg 3+3 (Fig. 6E), hind leg 2+2 (as in Fig. 6C). The hairs measure about 12 μ in length. Lengths of legs are : foreleg 0.720, midleg 0.811 and hind leg 0.915 mm.

Abdomen : The nine-segmented abdomen bears seven pairs of lateral spiracles in the first seven segments each being surrounded by a pigmented zone. The first two pairs of spiracles are situated somewhat closer and have the first pair of abdominal tubercles in between. The second pair of

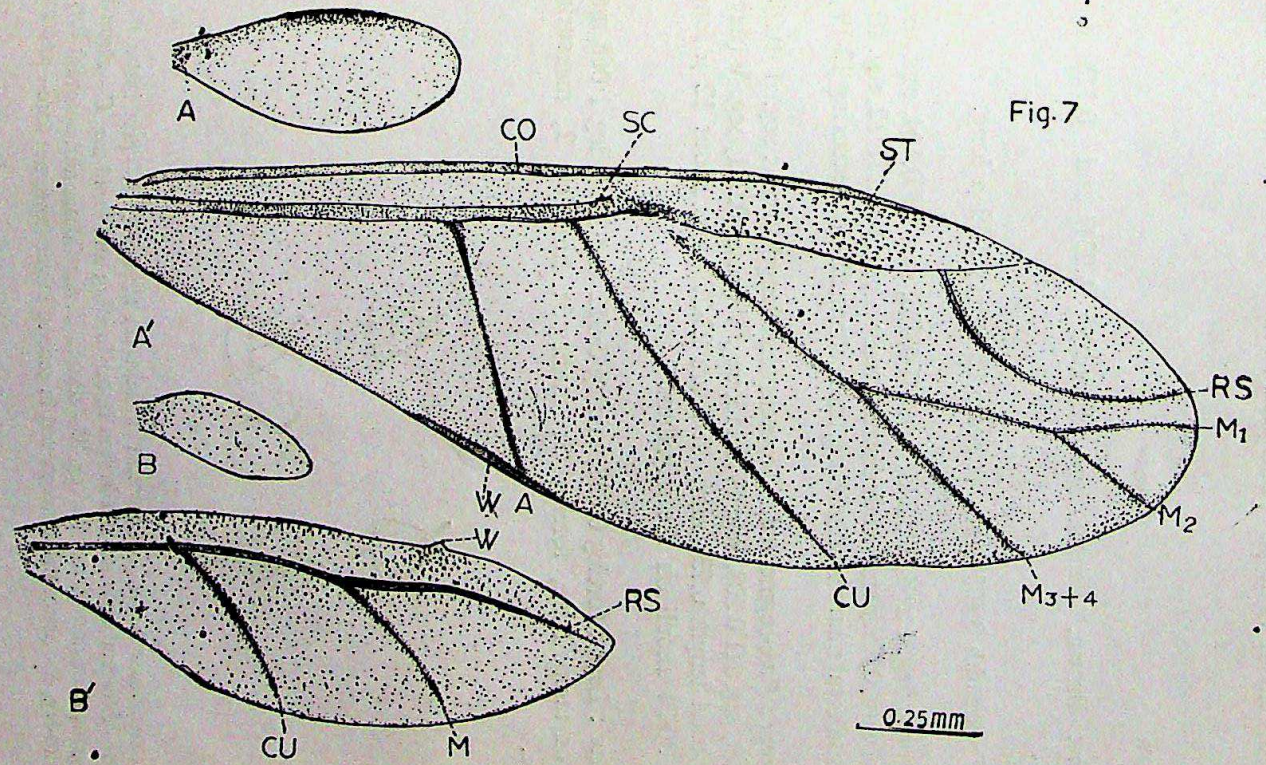

Fig. 7. *Aphis craccivora* Koch, wing buds in fourth instar alatae (A,B) and wings in alatae adult (A′, B′). A and A′ —fore-wings, B and B′—hind-wings, Al—anal, CO—costa, CU—cubitus, M—media, R—radial, SC—sub-costa, ST—stigma, W—wing coupling apparatus.

abdominal tubercles occurs on the seventh segment. Cornicle : length 0.109, basal breadth 0.075 and apical breadth 0.048 mm. Genital plate : bears 8-12 hairs about 19-28 μ. Anal plate : beset with 4-6 hairs measuring 38-41 μ.

THIRD INSTAR

Colour : Brown. Length and breadth : 1.231 and 0.718 mm. respectively.

Head : Breadth 0.403 mm. It bears 18 hairs 12-19 μ long.

Rostrum : Seg. I and II 0.245, seg. III 0.075, seg. IV 0.104, and total length of rostrum 0.426 mm. Hair distribution : seg. I and II 12, seg. III 4, seg. IV 8, and total number of hairs on the rostrum 22-26 measuring 12-19 μ.

Antenna : Five-segmented. Segmentwise lengths are : seg. I 0.066, seg. II 0.059, seg. III 0.208, seg. IV 0.113, seg. V (base) 0.081, seg. V (flag.) 0.198 and total length 0.730 mm. It bears 23-27 hairs about 12 μ long. There are 30-34 annuli on the flagellum.

Thorax : Legs : foreleg 0·838, midleg 0·912 and hind leg 1·068 mm. The hairs on tarsus I are, foreleg 3: midleg 3: hind leg 2, measuring about 12 μ.

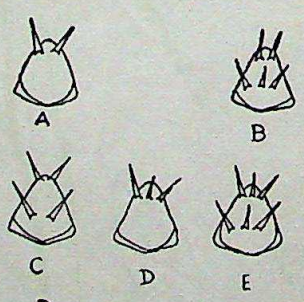

Fig. 6. *Aphis craccivora* Koch, arrangement of hairs on tarsus I. A—first instar in all legs, B—abnormal arrangement in first instar fore-leg and mid-leg, C—abnormal arrangement in first instar hindleg, D—second instar (alatae and apterae) fore—and mid-leg, E—abnormal arrangement in second instar (apterae) fore—and mid-leg.

Abdomen : Cornicle : length 0·171, basal breadth 0·085, and apical breadth 0·054 mm. Genital plate : bears 10—14 hairs 19—28 μ long. Anal plate : bears 5-6 hairs 53—57 μ long.

FOURTH INSTAR

Colour : Dark brown. Length and breadth : 1·469 and 0·960 mm. respectively.

Head : Breadth of head 0·419 mm. It bears 22—24 hairs 19 μ long. The number of ocular facets on the eyes have increased considerably. Their arrangement shows compactness to some degree.

Rostrum : Seg. I and II 0·266, III 0·078, IV 0·067, and total length of rostrum 0·449 mm. Hair distribution : Seg. I and II 12—14, III 4, IV 6—8 and total number of hairs on the rostrum is 22—26 measuring 19 μ.

Antenna : The antenna is six-segmented and is 0·859 mm long. Seg. V and VI (base) each bear sensoria. The flagellum bears 35—39 annuli. The segments are considerably imbricated. Seg I 0·068, II 0·057, III 0·149, IV 0·126, V 0·132 VI (base) 0·089, and VI (flag) 0·234 mm. Hair distribution : Seg. I 5, II 3-4 ,III 3—7, IV 4—7, V 4—6, VI (base) 3-4, VI (flag) 3—6 and the total number of hairs on the antenna is 28—36 measuring about 19 μ in length.

Thorax : Legs : Fore-leg 0·956, mid-leg 1·043 and hind-leg 1·258 mm. The number of hairs on tarsus 1 are : fore-leg 3, mid-leg 3, hind-leg 2, about 12 μ long.

Abdomen : Cornicle : Length 0·213, basal breadth 0·093 and apical breadth 0·059 mm. Genital Plate : bears 12—16 hairs 19—28 μ long. Anal plate : bears 6-7 hairs 53—57μ long.

ADULT

Colour : Shining black. Length and breadth : 1·992 and 1·153 mm. respectively.

Head : Breadth 0·468 mm., bears 22—24 hairs measuring about 19μ. The number of facets in the eye has increased considerably and they are arranged compactly.

Rostrum : Seg. I and II 0·306, III 0·089, IV 0·065 and total length of rostrum 0·514 mm. Hair distribution : Seg. I and II 14—16, III 4—6, IV 6 ; total number of hairs on rostrum : 24—28.

Antenna : Six-segmented, measures 1·361 mm. ; flagellum with 40—49 annuli ; Seg. I 0·079, II 0·070, III 0·332, IV 0·241, V 0·219, VI (base), 0·117, VI (flag) 0·299 mm. There are 26—38 hairs on the antenna about 19μ long.

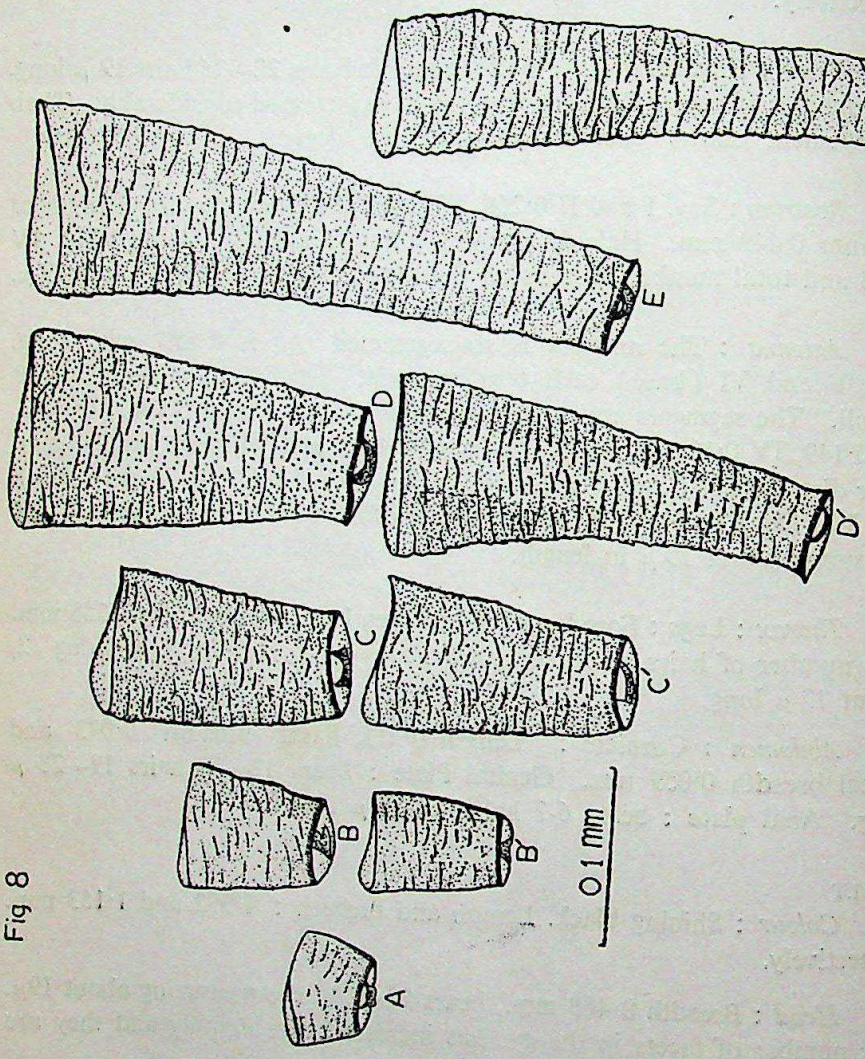

Fig 8

Fig. 8. *Aphis craccivora* Koch, cornicle. A, B—E and B′—E′ as in Fig. 1.

Thorax : The pro-thorax bears a pair of lateral tubercles. Legs : The sub-coxa of each leg shows the appearance of sternal apophysis and orifice (Bissell, 1969) towards the inner margin of the sub-coxal attachment to the body wall (Fig. 5). The cylindrical sternal apophysis projects internally. It is rounded at the distal end. The orifice from which the sternal apophysis arises is a simple rounded notch. Fore-leg 1·535, mid-leg 1·696 and hind-leg 2·106 mm. The number of hairs on tarsus I are : foreleg 3, mid-leg 3, hind-leg 2 measuring about 12μ.

Abdomen : The body of the abdomen is beset with reticulated lines giving the appearance of a mosaic, made up of small polygonal compartments. Corcinle : the length, basal breadth and apical breadth are 0·382, 0·097 and 0·053 mm. respectively. Genital plate : bears 13—15 hairs 19—28 μ long. Anal plate : bears 11—14 hairs 53—57 μ long. Cauda : distinct, black, spinose, broad at the base and narrower at the mid-point from both the sides ; bears 6-7 hairs 41—44μ long ; Length 0·213, breadth at the base 0·143 mm. (Fig. 11).

ALATAE

SECOND INSTAR

Colour : Grey. Length and breadth : 1·094 and 0·694 mm. respectively.

Head : Breadth 0·354 mm. ; bears 16—18 hairs 12μ long.

Rostrum : Seg. I+II 0·221, seg. III 0·076, seg. IV 0·102, and total length of rostrum 0·401 mm. Hair distribution : seg. I+II 12, seg. III 4, seg. IV 6 and the total number of hairs on the rostrum is 22—28. The hairs measure 12μ in length.

Antenna : Five-segmented. Seg. I 0·062, seg. II 0·053, seg. III 0·162, seg. IV 0·089, seg. V (base) 0·075, seg. V (flag) 0·180 and the total length of antenna : 0·625 mm. It bears about 25 hairs 12μ long. There are 25—29 annuli on the flagellum.

Thorax : The tarsus I of all the legs bear 3 hairs 12μ long. Legs : Fore-leg 0·750, mid-leg 0·799 and hind-leg 0·934 mm. The number of hairs on tarsus I are : fore-leg 3, mid-leg 3, hind-leg 2, measuring about 12μ.

Abdomen : Cornicle : length : 0·110, basal-breadth : 0·075 and apical breadth : 0·052 mm. Genital plate : bears 7—12 hairs 19—28 μ long. Anal plate : bears 4—7 hairs 38—41 μ long.

Fig. 8. *Aphis craccivora* Koch, cornicle. A, B—E and B'—E' as in Fig. 1.

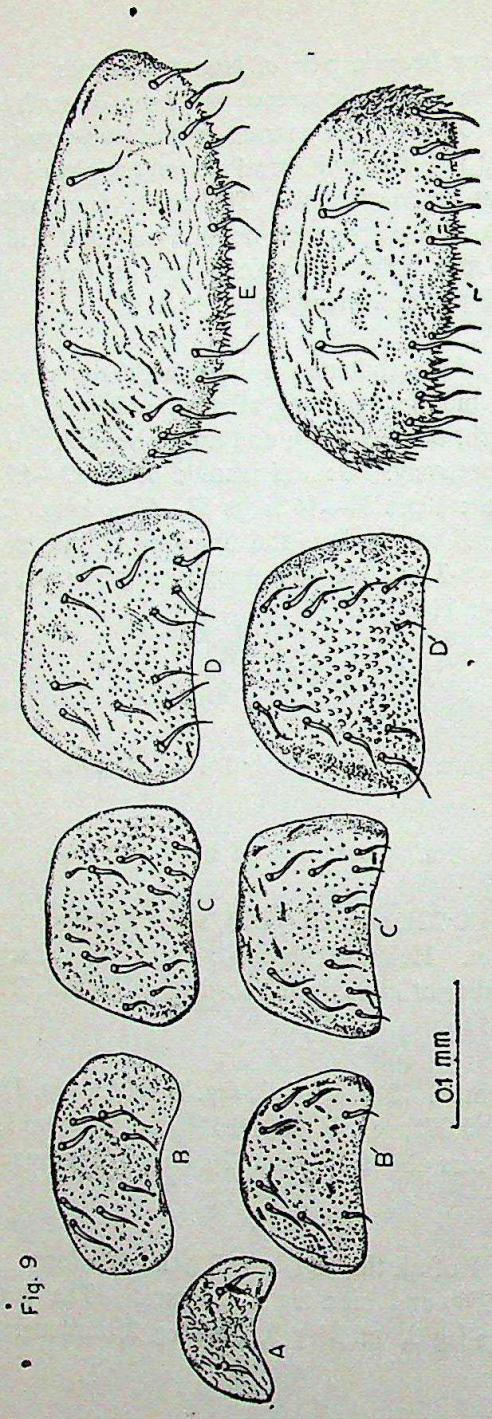

Fig. 9. *Aphis craccivora* Koch, genital plate. A, B—E and B′—E′ as in Fig. 1.

THIRD INSTAR

Colour : Grey. Length and breadth : 1·183 and 0·718 mm. respectively.

Head : Breadth 0·379 mm. ; bears 18—19 hairs 12—19μ long.

Rostrum : Seg. I+II 0·231, seg. III 0·072, seg. IV 0·105 and total length of rostrum 0·410 mm. Hair distribution : seg. I+II 12, seg. III 4, seg. IV 7 and total number on rostrum 22—26 measuring 12—19 μ.

Antenna : Five-segmented. Seg. I 0·062, seg. II 0·057, seg. III 0·223, seg. IV 0·120, seg. V (base) 0·080, seg. V (flag) 0·210 and the total length 0·756 mm. There are 23—31 hairs on the antenna measuring about 12 μ. The flagellum bears 30—34 annuli.

Thorax : Legs : Fore-leg 0·907, mid-leg 0·943 and hind-leg 1·090 mm. The number of hairs on tarsus I are . fore-leg 3, mid-leg 3, hind-leg 2 about 12μ long. But in only one specimen the hind tarsus I bears 3 hairs instead of 2.

Abdomen : Cornicle : length, basal breadth and apical breadth are respectively 0·140, 0·081 and 0·054 mm. Genital plate : bears 10—13 hairs 19—28μ long. Anal plate : bears 7—9 hairs 53—57μ long.

FOURTH INSTAR

Colour : Grey. Length and breadth : 1·422 and 0·815 mm. respectively.

Head : Breadth 0·386 mm. It bears 20—22 hairs measuring about 19μ in length.

Rostrum : Seg. I+II 0·292, seg. III 0·079, seg. IV 0·104 and total length 0·477 mm. Hair distribution : seg. I+II 13, seg. III 4, seg. IV 6 and the total number on the rostrum is 22—24 measruing about 19μ.

Antenna : Antenna six-segmented. The flagellum bears 35—39 annuli. Seg. I 0·067, seg. II 0·059, seg. III 0·197, seg. IV 0·176, seg. V 0·169, seg. VI (base) 0·098, seg. VI (flag) 0·266 and the total length of antenna is 1·038 mm. It bears 27—39 hairs measuring about 19μ in length.

Thorax : Wings : The meso-and meta-thoracic segments each bear a pair of wing-buds. The anterior pair is larger than the posterior pair. Legs : Fore-leg 1·107, mid-leg 1·173 and hind-leg 1·430 mm. Rudiments of the inner apodeme (Bissell, 1969) of sub-coxa is discernible. The number of hairs on the tarsus I are : fore-leg 3, mid-leg 3, hind-leg 2, measuring about 12μ long.

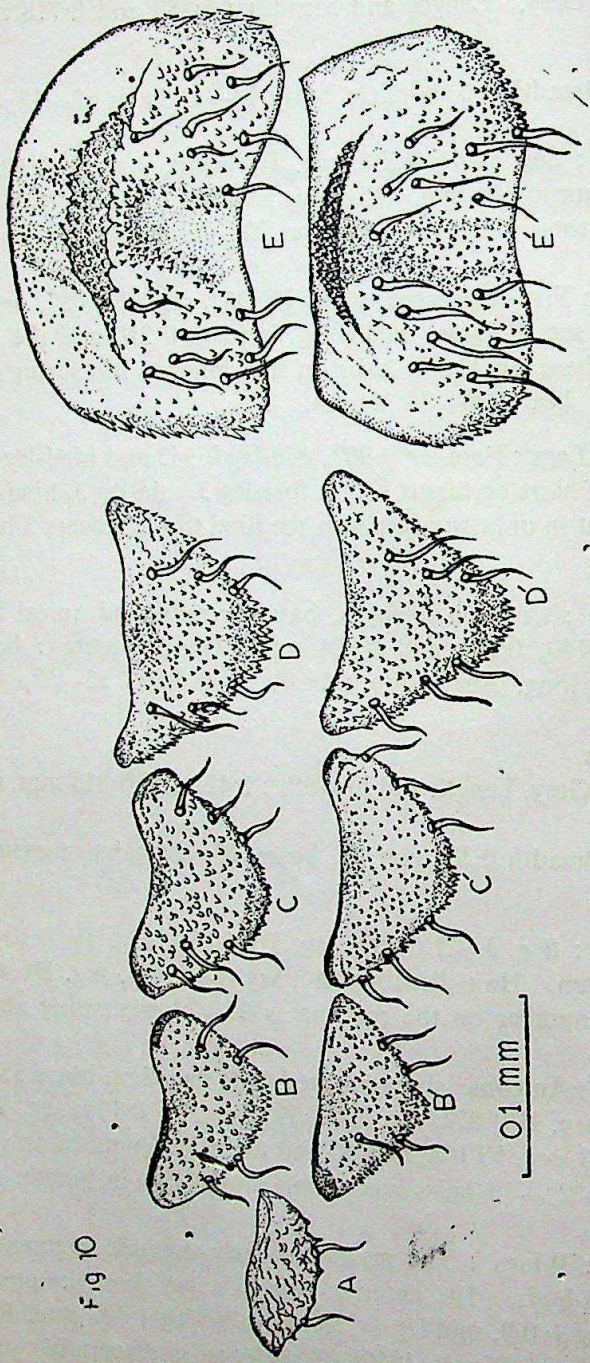

Fig. 10. *Aphis craccivora* Koch, anal plate. A, B—E and B′—E′ as in Fig. 1.

Abdomen : Cornicle : Length : 0·211, basal breadth 0·091 and apical breadth : 0·059 mm. Genital plate : it bears 12—16 hairs measuring 19—28 μ in length. Anal plate : It bears 6-7 hairs 53—57 μ long.

ADULT

Colour : Shinging dark. Length and breadth : 1·808 mm. and 0·864 mm. respectively.

Head : Breadth 0·421 mm. and it bears 22—28 hairs measuring about 19 μ in length. There are three ocelli on the head, one on the vertex and one on the dorsum adjacent to the inner face of each compound eye.

Rostrum : Seg. I+ II 0·338, seg. III 0·093, seg. IV 0·105 and total length 0·536 mm. Hair distribution : Seg. I+II 14, seg. III 4, seg. IV 6 and the toal number of hairs on the rostrum is 24. The hairs measure about 19μ in length.

The rostrum extends beyond the second coxae.

Antenna : The antenna is six-segmented and shows serrations on the distal 2/3 of seg. III and on the other remote segments. Seg. III bears 5—7 medium to large secondary sensoria. These are more or less circular in shape and arranged in a line. The flagellum is borne on the base of the seg. VI and bears 40—49 annuli. Seg I 0·071, seg. II 0·062, seg. III 0·293 seg. IV 0·252, seg. V 0·223, seg. VI (base) 0·119, seg. VI (flag.) 0·280 and toal length of antenna is 1·306 mm. The antenna bears 15—30 hairs about 19μ long.

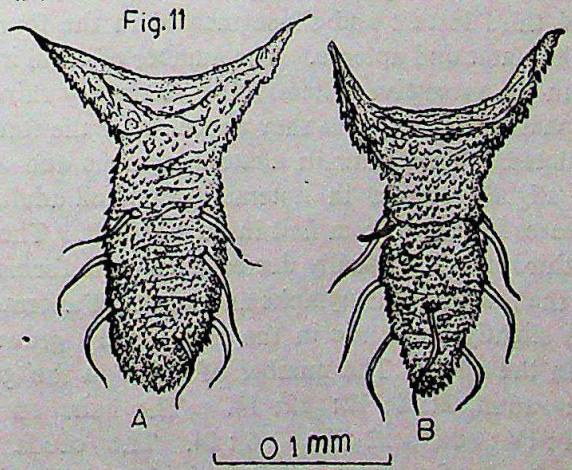

Fig. 11. *Aphis craccivora* Koch, cauda. A—apterous adult, B—alate adult.

Thorax : The description of the thorax and wings are the same as given for *Myzus persicae* (Sulz.) (Dash, 1974). Legs : The pleural ridge of the sub-coxa is prominent. Opposite to the pleural ridge is the shorter inner apodeme near the mid-line of the body (Fig. 5). It is rod-like and touches the coxa at one end. The sternal apophysis projects internally forward to the inner apodeme. The lengths of the legs are : fore leg-1·448, mid-leg 1·381 and hind-leg 1·782 mm. The number of hairs on tarsus I are : fore-leg 3, mid-leg 3, hind-leg 2. The hairs measure about 12 μ long.

Abdomen : Cornicle : The length, basal breadth and apical breadth of cornicle measure 0·253, 0·066 and 0·046 mm. respectively. Genital plate : bears 12—14 hairs 19—28μ long. Anal Plate : bears 11—16 hairs 53—57μ long. Cauda : Length 0·143 and breadth at the base 0·122 mm. It bears 4—7 hairs 44—53 μ long.

RESUME

The nymphal morphology of apterous and alate *Aphis craccivora* Koch was studied in the Laboratory at Bhubaneswar, Orissa during December, 1974 and January ,1975 at the temperature of 20·3°C and 20°C respectively. The first instar nymphs of both the forms are almost colourless to pale. The rymphs of both the forms in successive instars differ in their body colouration, apterae nymphs being light to dark brown and alloatoid nymphs grey in colour.

The antenna is four-segmented in the first instar, five-segemented in the second and third instars and six-segmented in the fourth instar and adult in both the alatae and apterae. The number of ocelli in the eye gradually increases in the successive instars. The secondary rhinaria are absent in all the nymphal instars where as they appear after the fourth moult only in the adult alatae. The femur in allatoid nymphs and adult is slender whereas it is slightly stouter in apterae instars and adult. The cornicle gradually increases in length from first instar to adult. The breadth of the cornicle after third moult gradually decreases in alate forms in contrast to its increase in the fourth instar nymphs and adults of apterae. The genital plate which is slightly crescentic in the first instar grows gradually to become oval in the adult. The number of hairs on the genital plate are I: II: III: IV: adult, 2: 8: 12: 12: 14. The hairs on the anal plate are I : II : III : IV : adult, 2 : 4 : 6 : 6 : 14. The cauda separates from the anal plate after the fourth moult in both alatae and apterae. It bears 4—7 and 6-7 hairs in alatae and apterae respectively. The measurements

(in mm) of morphological characters of different instars of *A. craccivora* are given in Table 1.

The alate adults differ from the apterous adult in some unique features like possession of three ocelli on the head, extension of rostrum slightly beyond the second coxae, presence of secondary rhinaria on the third antennal segment, presence of scutum, scutellum and paired thoracic lobes on the meso-thorax, possession of two pairs of wings on the meso-and meta-thorax, appearance of inner apodeme on the sub-coxa and the presence of sclerotic patches on the abdomen.

TABLE 1

The measurements (in mm.) of morphological characters of different instars of Aphis craccivora *Koch.*

Form	Instar	Body length	Antenna	Rostrum	Fore-leg	Mid-leg	Hind-leg	Cornicle	Cauda
Apterae	I	0·738	0,383	0·319	0·527	0·560	0·627	0·053	...
	II	1·176	0·565	0·387	0·720	0·811	0·915	0·109	...
	III	1·231	0·730	0·426	0·838	0·912	1·068	0·171	...
	IV	1·469	0·859	0·449	0·956	1·043	1·258	0·213	...
	Adult	1·992	1·361	0·514	1·535	1·696	2·106	0·382	0·213
Alatae	II	1·094	0·625	0·401	0·750	0·799	0·934	0.110	...
	III	1·183	0·756	0·410	0·907	0·943	1·090	0·140	...
	IV	1·422	1·038	0·477	1·107	1·173	1·430	0·211	...
	Adult	1·808	1·306	0·536	1·448	1·381	1·782	0·253	0·143

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THE FRESH-WATER FISHES OF SAMBALPUR (ORISSA)

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INTRODUCTION

Sambalpur lies about 325 kilometers west of Bhubaneswar, the capital of Orissa. It is about 340 kilometers away from the Bay of Bengal. The importance of Sambalpur has gone up after the construction of the famous Hirakud dam on river Mahanadi. Two more small townships, namely Burla and Hirakud have sprung up, one on either side of river Mahanadi. The gap between these three townships is gradually narrowing. So in this paper in addition to that of Sambalpur, the fresh-water fishes available at Burla and Hirakud have also been taken into account.

Sambalpur, Burla and Hirakud are hilly areas with an elevation of 182 metres (600 feet) above sea level. Sambalpur covers an area of 31 square kilometres (16 square miles) with a population of 90,000. Burla covers an area of 15 square kilometers (6 square miles) with a population of 30,000. Hirakud covers an area of 11 square kilometers (4.5 square miles) with a population of 20,000. Only fresh-water fishes are available in these three townships. Most of these fishes are netted from river Mahanadi, the Hirakud reservoir and a large number of ponds. The reservoir has an area of 737 square kilometres (288 square miles) and supports a large variety of fishes. The Government fish farms at Sambalpur, and Burla culture a number of species. The Sambalpur fish farm has about 40 nursery tanks with an arrea of 32.4 acres. Apart from these there are many private fish farms in and around Sambalpur supplying fish to the local population. Still then sometimes it becomes necessary to import some species of marine fishes from Cuttack and Puri to meet the demand of the local population.

Although Orissa has a rich fish fauna, little attempt has so far been made to collect, identify and systematically arrange these fishes. Some preliminary work has only been done by Mishra and Das (1966) and Mohapatra and Mishra (1969), who have collected and identified some of the fishes of Cuttack and Puri respectively. The collection and identification of the fishes available in the hilly areas of Sambalpur has not yet received any attention. Therefore an attempt has been made in the present

work to collect and identify the common fresh-water fishes of Sambalpur, Burla and Hirakud.

METHODS

From 1964 to 1970 a large number of fishes were collected from the markets of Sambalpur, Burla and Hirakud. They were identified after Day (1878, 1888 and 1958); Munro (1955); Mishra (1962) and Weber and de Beaufort (1953). The Local names were selected from the most widely used terms of the local residents.

Table 1.

List of families, genera and species of fish seen at Sambalpur, Burla and Hirakud

Name of the family	No. of genera	No. of species	Name of the family	No. of genera	No. of species
Ambassidae	1	2	Mugilidae	1	1
Anabantidae	1	1	Mastacembelidae	1	3
Anguillidae	1	1	Nandidae	2	2
Belonidae	1	1	Notopteridae	1	3
Bagridae	2	6	Ophiocephalidae	1	4
Cyprinidae	13	24	Platycephalidae	1	1
Claridae	1	1	Saccobranchidae	1	1
Clupeidae	1	1	Symbranchidae	1	1
Chepeidae	1	1	Siluridae	6	7
Gobiidae	1	1			

RESULTS AND DISCUSSIONS

As many as 62 species of fresh-water fishes belonging to 38 genera and 19 families were identified (Table 1). The list of fishes available in Sambalpur, Burla and Hirakud is presented in Table 2.

Mishra and Das (1966) have reported 39 species of fresh-water fishes belonging to 28 genera and 13 families from Cuttack Out of these, 26 species of fishes (marked with one and three asterisks in parenthesis in table 2) belonging to 19 genera and 13 families are available at Sambalpur, Burla and Hirakud. Mohapatra and Mishra (1969) have reported 22 species of fresh-water fishes belonging to 16 genera and 11 families from Puri and all these species (marked with two and three asterisks in parenthesis in table 2) are available at Sambalpur, Burla and Hirakud. The district of Sambalpur covers a hilly area with an elevation of 182 metres (600 feet) above the sea level, whereas Cuttack and Puri are districts lying in the coastal plains. The soil condition and the nature of the river bed in Sambalpur are different from that of Cuttack and Puri. The average temperature of Sambalpur is higher than that of Cuttack and Puri and the average humidity of Sambalpur is lower than that of Cuttack and Puri. These factors may partly explain the record of additional 27 species of fishes in Sambalpur (marked without asterisks in table 2) not reported from Cuttack and Puri by Mishra and Das (1966) and Mohapatra and Mishra (1969).

During the period of the present investigation *Hilsa ilisha* were netted from river Mahanadi at Sambalpur. It was previously believed that the migration of *Hilsa* in the river Mahanadi is limited upto the Naraj dam at Cuttack. *Labeo gonius* and *Labeo fimbriatus* are available in the river Mahanadi and not in the ponds. *Tortor*, *Silundia silundia*, *Silundia gangetica*, *Pangasius pangasius* and *Mystus aor* are available only in river Mahanadi and the Hirakud reservoir and not in tanks. *Clarias batrachus*,

Table 2.

List of fresh-water fishes of Sambalpur, Burla and Hirakud

Family	Scientific name	Local name in Oriya
Ambassidae	*Ambassis nama* (*)	Pātpaniā
	Ambassis ranga	Cārtkāṇā
Anabantidae	*Anabas scandens* (***)	Kau
Anguillidae	*Anguilla bengalensis*	Thumbe
Belonidae	*Xenetodon (Belone) cancila*	Gaurchulā
Bagridae	*Mystus gulio*	Kukiā
	Mystus cavasius (*)	Tengni
	Mystus aor (*)	Ālli
	Mystus seenghala (**)	Ādi

Table 2.—*contd.*

Family	Scientific Name	Local name in Oriya
	Mystus vittatus (*)	Tengnā
	Rita rita	Patharchatā
Cyprinidae	*Amblypharyngodon mola* (*)	Mahārel
	Catla catla (*)	Bhākur
	Cirrhina mrigala (***)	Mirkāli
	Cirrhina reba (*)	Chhunchiā puhudā
	Cyprinus carpio	Bilāti rohi
	Ctenopharyngodon idellus	Grass carp (English)
	Danio rerio	Jhāin
	Danix devario	Bunkuāsai
	Hypophthalmicthys molitrix	Silver carp (Eng.)
	Labeo rohita (***)	Rohi
	Labeo calbasu (***)	Kalābāinsi
	Labeo gonius	Khursā
	Labeo bata	Puhudā
	Labeo fimbriatus	Khursā
	Osteobrama vigorosii	Chilānti
	Oxygaster bacaila	Jardā
	Puntias sarana (*)	Sarnā
	Puntias sophore (**)	Sān kutri
	Puntias ticto (**)	Putiā
	Puntias vittatus (**)	Bad kutri
	Puntias amphibius	Kutri
	Rasbora doniconius	Dandei
	Tor tor	Mahāseer
	Tor putitora	Kudo
Clariidae	*Clarias batrachus* (***)	Māgur
Clupeidae	*Gadisia chapra*	Palei
Chepeidae	*Hilsa ilisha* (*)	Ilsi
Gobiidae	*Glossogobuis giuris M* (***)	Ghesrā
Mugilidae	*Rhinomugil corsula*	Khaingā
Mastacembelidae	*Mastacembelus pancalus*	Bainri
	Mastacembelus armatus (***)	Khadā baingrā
	Mastacembelus aculeatum (**)	Tudi
Nandidae	*Badis buchanani*	Kālpani
	Nandus nandus	Bhādrā
Notopteridae	*Notopterus notopterus* (*)	Bhādul
	Notopterus chitala (***)	Chital

Table 2.—*contd.*

Family	Scientific name	Local name in Oriya
	Notopterus kapirat (**)	Phalli
Ophiocephalidae	*Ophiocephalus striatus* (***)	Seol
	Ophiocephalus gachua (*)	Jiā
	Ophiocephalus punctatus (***)	Khabsi
	Ophiocephalus marculius	Sahala
Platycephalidae	*Platycephalus* sp.	Mātul
Saccobranchidae	*Saccobranchus fossilis* (***)	Singhi
Symbranchidae	*Amphipnous cuchia* (***)	Kuchiā
Siluridae	*Ailia coila* (*)	Bānspatri
	Eutropiichthys vacha (*)	Bachā
	Pseudeutropius gaura (**)	Pāniā vachā
	Pangasius pangasius (**)	Jalanga
	Silundia gangetica (**)	Jallung
	Silundia silundia	Jallung
	Wallago attu (***)	Bāliā

(*) Fishes also available at Cuttack (Mishra and Das, 1966)

(**) Fishes available at Puri (Mohapatra and Mishra, 1969)

(***) Fishes available both at Cuttack and Puri (Mishra and Das, 1966; Mohapatra and Mishra, 1969)

Anabas scadens, *Amphipnous cuchia*, *Ophiocephalus striatus*, *Ophiocephalus gachua*, *Ophiocephalus punctatus* and *Ophiocephalus marulius* are fishes with accessory respiratory organs. They occur in marshy ponds and nearby rice fields. *Cyprinus carpio*, *Ctenopharyngodon idellus*, and *Hypophthalmicthys molitrix* are exotic fishes and are bred at the local government fish farm. The investigation reveals that Sambalpur is quite rich in fresh-water fishes.

Acknowledgement

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SUMMARY

The fresh-water fishes of Sambalpur, Burla and Hirakud includes 62 species belonging to 38 genera and 19 families. Most of them occur in river Mahanadi, Hirakud reservoir and the numerous ponds in or around these three townships. *Hilsa ilisha* migrates upto Sambalpur in river Mahanadi.

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EFFECT OF INFESTATION OF *SCIRTOTHRIPS DORSALIS* HOOD (THRIPIDAE, THYSANOPTERA) ON THE GROWTH AND YIELD OF GROUNDNUT

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Abstract

A pot culture experiment was conducted to determine the effect of infestation of *Scirtothrips dorsalis* Hood on the growth characteristics and yield of groundnut plant. The results indicated that both the growth and yield of groundnut crop were adversely affected due to infestation of the thrip. In the severely attacked plants there was a reduction of 37·89, 29.47, 18·10, 34·78 and 25·21 per cent in number of leaves, number of branches height, leaf size and pod yield respectively as compared to the healthy plants.

INTRODUCTION

The occurrence of *Scirtothrips dorsalis* Hood (Thripidae, Thysanoptera) on groundnut has been reported from peninsular India (Vevai, 1969). During recent years it was noticed that this insect inflicts severe damage to both *kharif* and *rabi* groundnut crops by its regular appearance in Orissa conditions. The infestation of this pest is manifested by stunted growth of the plants, crinkling and dwarfing of leaves and ultimate loss in crop yield(Ananthakrishnan, 1971) but quantitative information on the extent of stunting of the plant or dwarfing of the leaf caused by the insect species at various levels of infestation are not available. An experiment was, therefore, conducted to obtain some preliminary information on the relationship that might exist between infestation level and growth and yield of groundnut plant.

MATERIAL AND METHODS

Groundnut seeds var. A. K. 12--24 were sown in 100 earthen pots of size 30×30 cm at the rate of 2 seeds per pot during the *rabi* season of 1972-73. After germination, only one plant was allowed to grow in each pot. The fertility level and all the agronomic practices were kept uniform for all the plants in the pots. The plants were divided into five equal lots

with 20 pots in each lot. With a view to cause differential level of infestation by the thrip, insecticidal protection with alternate applications of parathion and metasystox at the concentration of 0·05 per cent (a.i.) was given to 80 plants (4 lots each consisting of 20 plants) at four treatment schedules basing on the interval of applications *viz.*, 7 (T_1) 14(T_2), 27(T_3) and 28 (T_4) days (one schedule being limited to one lot) and 20 plants were kept as untreated control (T_5). The insecticides were applied with the help of a high volume nursery sprayer upto the stage of run off from the plant surface.

Observations on the total number of leaves of a plant and the numbers of leaves infested by the thrips in the same plant were taken thrice *i.e.*, when the plants were 30, 40 and 50 days old. The average of these three observations was taken to determine the percentage leaf infestation of a plant. Plants having varying percentage leaf infestation were classified into three categories viz., low (1 to 20 per cent), moderate(21 to 50 per cent) and severe (above 50 per cent). Plants with no sign of thrip infestation were considered as healthy. Individual plants after the third observation were tagged with labels showing the percentage of leaf infestation. Ten plants from each of the above categories were taken for subsequent observations. Observations on the total number of leaves and branches, height of the plant and average size of the leaf were recorded when the plants were 50 to 53 days old. For measuring the leaf size, three leaves *i.e.*, 2nd, 4th and 6th leaf from the top were included and the average was computed. Pod yield of all these plants were also recorded.

RESULTS

The untreated as well as the plants treated at 28 days interval recorded severe infestation of the thrip species which resulted in arrest of growth of the plants and dwarfing of the leaves [Fig. 1(*a*) and (*b*)]. The data presented in Table 1 indicated that the increase in thrip infestation caused a corresponding decrease in height, number of branches and leaves and size of the leaf of groundnut plant. Compared to the healthy plants there was reduction of 37·89 and 34.78 per cent in number of leaves per plant and leaf size respectively in the severely attacked plants. Yield being mainly dependent upon the functional ability of the leaves, the reduction in number and size of the leaf resulted in decrease of 25.21 per cent pods by weight in severely attacked plants. The difference between plants of healthy and low infested groups was not statistically significant for different growth characters studied except in case of branching. Similarly, moderately and severely attacked plants did not show significant difference in respect of any of the factors examined.

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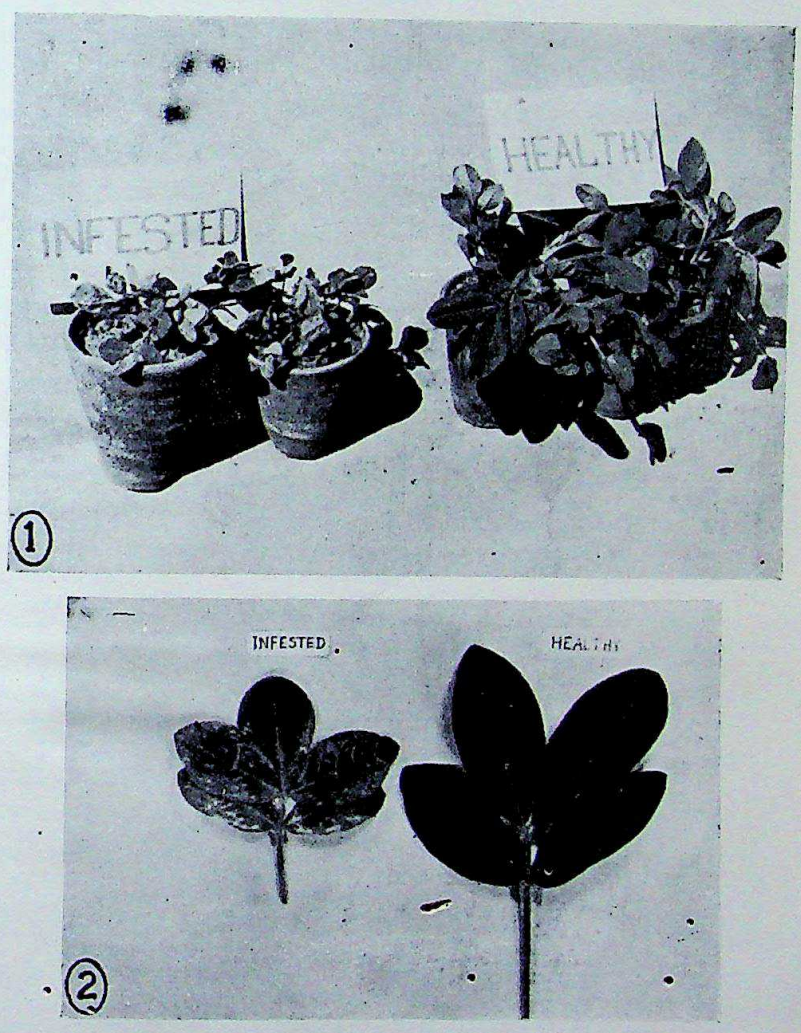

Fig. 1 (*a*) Comparison of growth in infested and healthy groundnut plants

(*b*) Infested groundnut leaf showing dwarfing and deformation symptoms in comparison to healthy one.

TABLE 1

Effect of infestation of Scirtothrips dorsalis *Hood on leaf number, branching, plant height, leaf size and pod yield of groundnut (Average of 10 plants for each plant character).*

Level of infestation		Number of leaves/ plant	Number of branches/ plant	Plant height (cm)	Leaf size (sq.cm)	Pod yield/ plant (gms)	Percentage reduction as compared to healthy plant in				
Plant category *	Percentage of leaf infestation						Number of leaves	Number of branches	Plant height	Leaf size	Pod yield
Healthy	0	62·8 a	9·5 a	27·35 a	58·99 a	17·69 a	...	...	...	...	...
Low	8·5	51·6 ab	7·3 bc	24·05 ab	56·63 a	16·64 ab	17·83	23·15	12·06	4·00	5·93
Moderate	35·09	40·4 bc	7·4 bc	23·36 abc	44·95 b	14·11 bc	35·66	22·10	14·58	23·80	20·23
Severe	64·25	39·0 bc	6·7 bc	20·91 bc	38·47 b	13·23 c	37·89	29·47	18·10	34·78	25·21
"F" test		Sig.	Sig.	Sig.	Sig.	Sig.					
(S.E)m ±		6·710	0·660	1·505	2·874	1·322	...	...	...	...	...
C.D. (P=0·05)		13·768	1·915	4·366	8·338	2·712					

Similar letters on the figures indicate that the differences are non-significant for a particular plant character.

* Healthy — 0% infestation
Low — 0—20% infestation of leaves
Moderate — 21 to 50 % infestation of leaves
Severe — above 50% infestation of leaves

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STUDIES ON THE CHROMOSOMES OF A MILLIPEDE, *THYROPYGUS NIGROLABITUS* (NEWPORT) (HARPAGOPHORIDAE: DIPLOPODA : ARTHROPODA)

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ABSTRACT

The behaviour, morphology and metrical data of chromosomes during spermatogenesis in a millipede, *Thyropygus nigrolabitus* of family Harpagophoridae has been studied. The spermatogonial chromosome number is 24 and the mean length in microns of haploid set of chromosomes was 21-46.

INTRODUCTION

The chromosomal data in determining the natural relationships and modes of evolution have been amply applied in various groups of Insecta. (see White, 1954 ; Makino, 1956 ; Manna, 1962 ; Smith, 1953, 1960 etc.) From this point of view, however, not much attention has been paid to the millipedes. The number of millipede species among arthropods is only seven out of one thousand (Storer and Usinger, 1965), The morphological studies have been carried out mainly by the earlier workers (Pocock, 1892 ; 1899 ; Silvestri, 1916, 1917, 1920, 1923 ; Attems, 1936).

Our knowledge on millipedes of India is limited (Silvestri, 1917 ; Carl, 1932 ; Krishnan, 1967) and only about 92 genera and 290 species (Attems, 1936) have been recorded. The phylogenetic studies on Diplopoda has not yet been done (Krishnan, 1967). The paucity of cytological data on the Indian species and the interesting findings of the previous workers (Natarajan, 1959 ; Chowdaih, 1965, 1966, 1970) led the present authors to undertake the cytological survey of individuals of *Thyropygus nigrolabitus* population occuring in the adjacent area of Utkal University campus, Vani Vihar, Bhubaneswar.

MATERIAL AND METHODS

Adult males of *T. nigrolabitus* belong to family Harpagophoridae, Order Spirostreptida, superorder Helminthomorpha, subclass Chilognatha,

Class Diplopoda, superclass Progoneata of Phylum Arthropoda were collected from the moist green and shady places during August to October, 1973. The testes were dissected out in normal saline and were fixed in acetoalcohol (1 : 3). The squash preparations were stained in Haeidenhan's haematoxyline for the study of chromosomes. Metrical data and idiograms of spermatogonial chromosome complement were done according to the following procedures.

Metrical data : For measuring the chromosomes, five well spread spermatogonial metaphase chromosome complements from different individuals were drawn on a paper with the help of a camera lucida. Then the length of individual chromosome from one end to the other irrespective of the position of the centromere (as it was not distinct) was measured and the data of autosomes were homologised and arranged in decreasing order of the sizes. The mean value for each chromosome was taken from the data of five complements. The justification of measuring spermatogonial metaphase chromosomes was that at metaphase I the shapes of the bivalents were variable and at metaphase II over condensed chromosomes were unsuitable for measurements. The relative percentage value of each chromosome was calculated by taking the total of haploid complement as 100.

Preparation of caryotypes : The chromosomes of well spread spermatogonial complements were drawn on a paper with the help of a camera lucida. The drawing of each chromosome of a gonial complement was cut and pasted on a paper by putting homologous autosomes in pairs according to decreasing order of sizes. The sex chromosomes were pasted separately after the autosomal pairs. The whole set was then redrawn.

OBSERVATION

Spermatogonial metaphase

After observing a number of prometaphases (Plate 1, Fig. 2) and metaphases the diploid number is confirmed to be 24 ; 22AA+XY (Plate I Fig. 1 and Plate II, Fig. 1). The autosomes can be classified into three size groups ; (*i*) 3 pairs of long, (*ii*) 5 pairs of medium and (*iii*) 4 pairs of dot shaped chromosomes (Plate I, Fig. 1). The karyotypic arrangement (Plate III, Fig. A) and the idiogram (Plate III, Fig. B) reyealed that an unequal pair is the sex element, the larger one of which has been designated as the X and the smaller one as the Y. The sex chromosomes are small dots and fall under the third category. All the chromosomes, are acrocentric. The metrical analysis (Table 1) showed that the sex chromosomes constitute 8·43% of the chromosome complement.

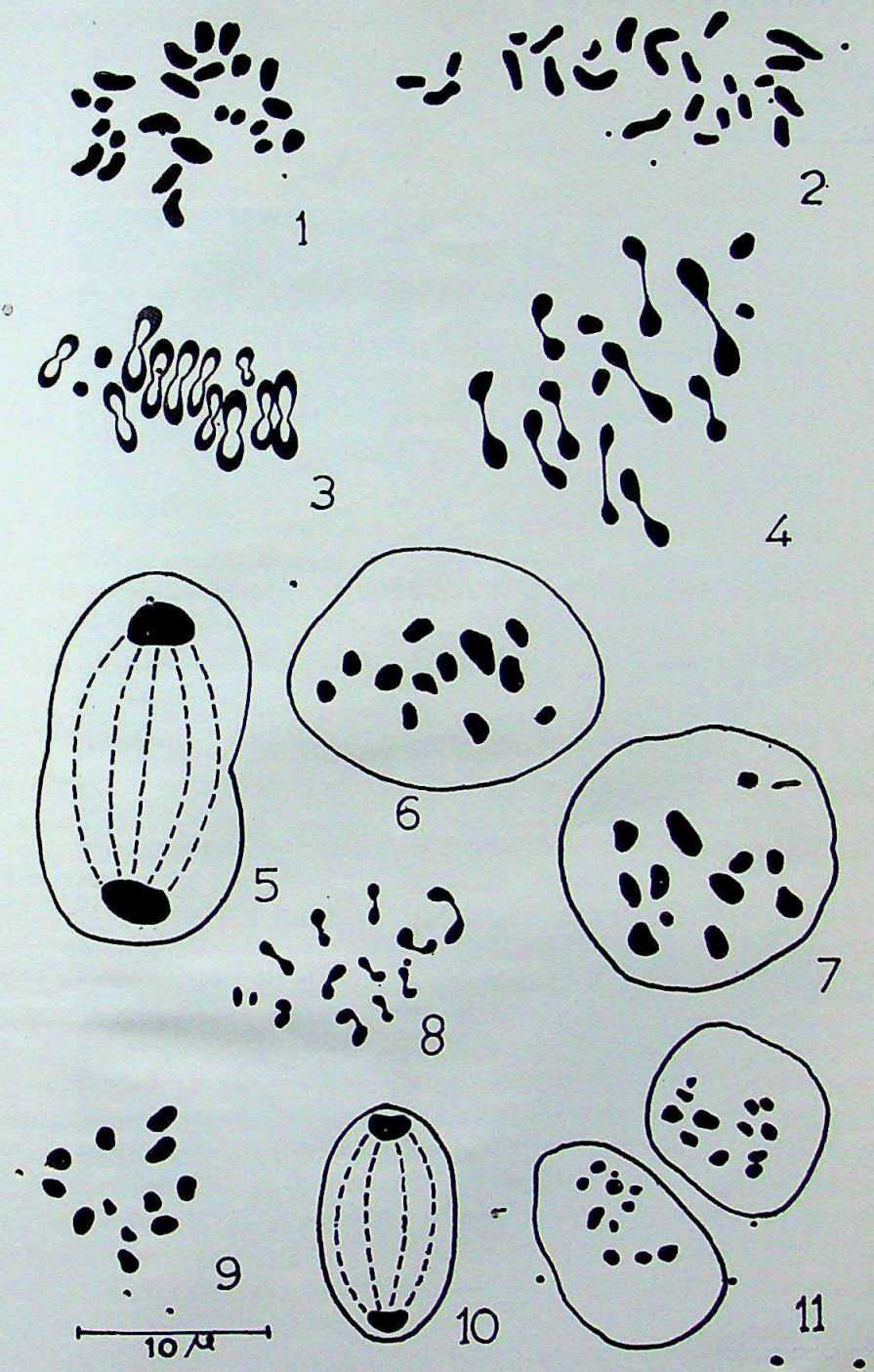

PLATE No. 1

FIGS. 1—11 : Meiosis in *Thyropygus nigrolabitus*

1. Spermatogonial metaphase (2n=24) ; 2 : prometaphase ;
3. Metaphase I, side view showing dumb-bell shaped bivalents ;
4. Early Anaphase, I, side view ; 5 Telophase I, side view ; 6-7. Sister groups of Anaphase I, side view ;
8. Methaphase II, side view ; 9. Metaphase II, polar view.
10. Telophase II ; 11. Sister groups of anaphase II, polar view.

Prakruti—Utkal University Journal—Science
Vol. 9 (1—2), 97—104, 1972

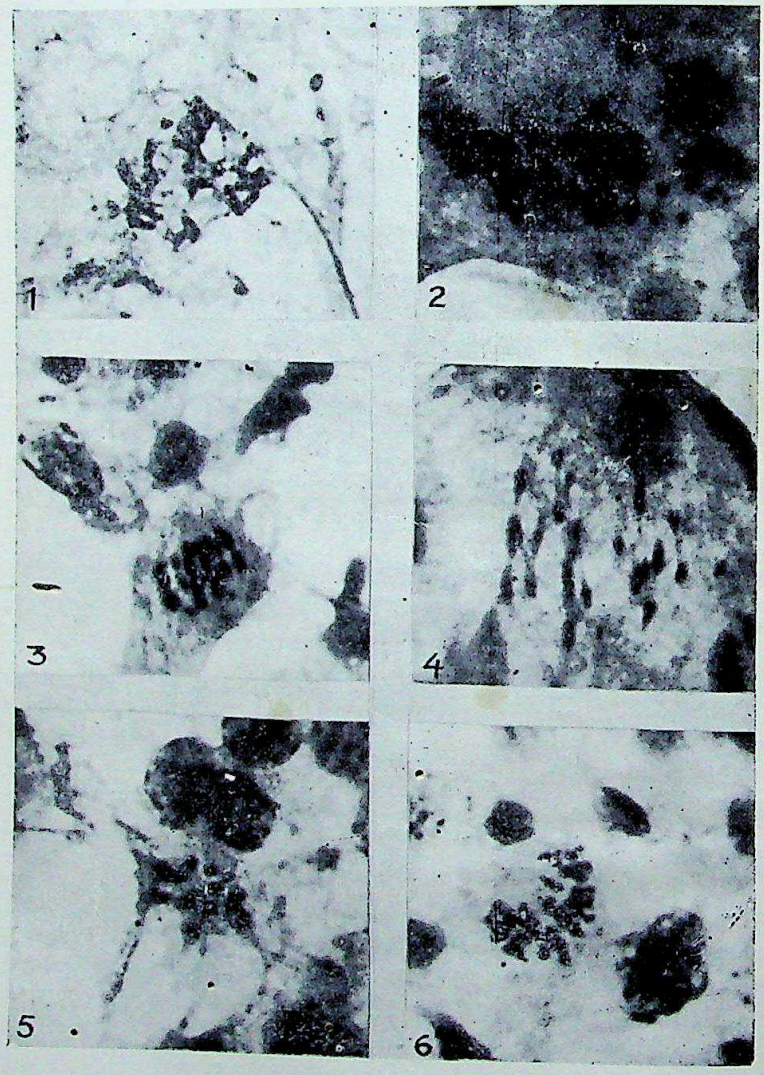

PLATE No. 2

Photomicrographs

1. Spermatogonial metaphase ;
2. Late metaphase, I, side view ;
3. Metaphase I, side view ;
4. Early anaphase I, side view ;
5. Anaphase II, polar view ;
6. Early prophase nuclei.

Primary Spermatocyte Prophase

In the very early spermatocyte prophase stage, termed as the contraction phase, two positively heteropycnotic bodies, one of which is quite large and other relatively small are found to be closely associated occupying

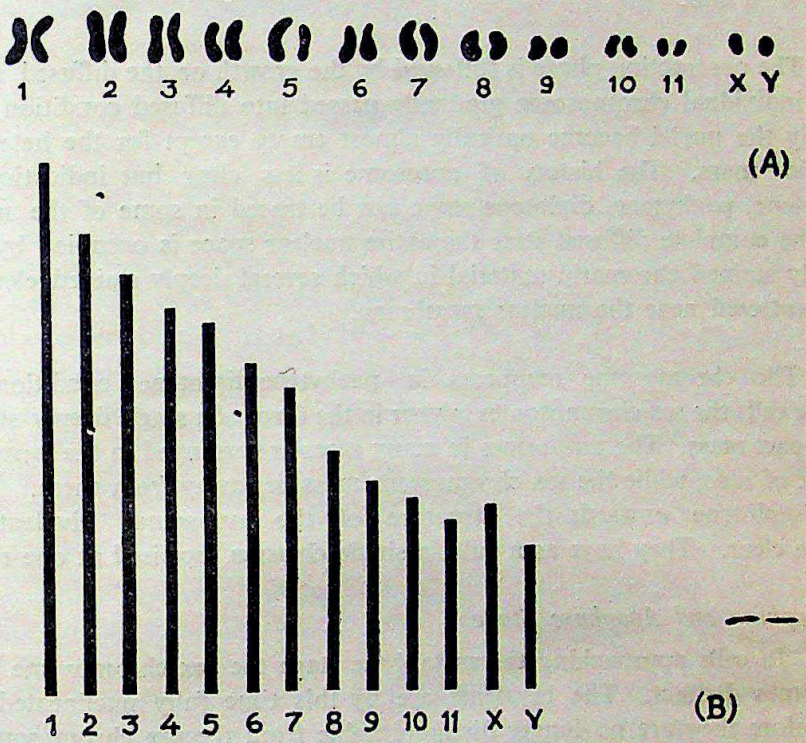

PLATE No. 3

A. Karytype of Spermatogonial metaphase chromosomes of *Thyropygus nigrolabitus*.

B. Idiogram showing the relative length of chromosomes.

about 1/8th of the nuclear space. In most of the nuclei these bodies cannot be separately distinguished but they appear as a single large deeply stained mass (Plate II, Fig. 6). The remaining portion of the nuclei is partially filled up by what appears to be an entangled mass of threads with a few vacant space which remains optically empty. It is not likely that these delicate threads do not always correspond to what has been described above. Thus a 'boquet' arrangement is sometimes seen where the ends of the chromosome are oriented towards the nuclear membrane. Along with the large heteropycnotic bodies, a few smaller heteropycnotic bodies are also found in these nuclei but they invariably lie near the nuclear membrane (Plate II, Fig. 5). They are likely to be the heterochromatic segments of

autosome, for the fused larger chromosomes which will be shown to have a peculiar behaviour throughout the meiotic cycle. The nature of their association of two large heterpycnotic chromosome elements can be observed only in certain favourable nucli where they are separately distinguished. These two large heteropycnotic elements are associated either side by side or end to end.

The contraction phase is followed by the growth or the diffused stage. The individual chromosome gradually passed into diffused condition until finally the nuclei become optically almost empty except for the heteropycnotic mass. The history of autosome is less clear but indications of zygotene, pachytene, diplotene stage can be traced in some of the nuclei. At the complete diffused state the entire nuclear space is occupied by very feebly stained chromatin material in which several deeply stained elements lie scattered near the nuclear membrane.

The chromosome reappears in pachytene-diplotene condition. In these cells the sex chromosomes appear in the form of a single deeply stained compact mass. The autosomes in many cases are arranged in the form of a pack of rods, while the sex chromosome mass lies away from them. From the diplotene onwards the structure of the autosomal bivalents are quite clear. They have as a rule, a single chiasma localised at one end.

Metaphase and Anaphase Stage

In cells approaching the metaphase stage the sex chromosome again becomes distinct. The bivalents are by this time fully nuclineated and therefore they are no longer distinguishable from the sex chromosome by their staining behaviour (Plate II, Figs. 2, 3). In Metaphase I (Plate I, Fig. 3), 12 bivalents having dumb-bell sharped appearance are seen of which one is heteromorphic sex bivalent (X Y), the X being larger than the Y.

At the initiation of Anaphase I (Plate I Fig. 4, II, Fig. 4) each member of the bivalent divides equationally and migrate towards the pole. Thus the first meiotic division is reductional for chromosomes. The disjunction of the autosomal bivalents is regular. The separation of the bivalents is asynchronous with autosomes. The heteromorphic sex chromosome pair separates earlier than autosomal bivalents (Plate I, Fig. 4, 6, 7).

Second Meiotic Division

The second metaphase stage (Plate I, Fig. 8, 9 and Plate II, Fig. 5) contains 12 elements *i.e.*, one sex chromosome and 11 regular autosomes. Anaphase II division (Plate I, Fig. 11 Plate II, Fig. 5) is distinguished

from Metaphase II only on the morphology of the chromosome, number being constant. The second division is equational for all the chromosomes and the behaviour of the sex chromosome is normal. The second meiotic division naturally leads to the formation of two kinds of sperms in equal numbers. One contained 12 elements including one X and the other with same number of elements with Y.

DISCUSSION

The cytology of only a few species of Diplopoda has so far been studied (Table I). Among the earlier contribution to the field of diplopodan cytology, mention may be made of Oettinger (1909), Sokoloff (1914) and Bessire (1948). The first two worked on *Pachyiulus varius* and *Polyxenus* sp. respectively. Unfortunately they did not present a complete picture of meiosis of these forms and it appeared they have paid greater attention to aspects of cellular inclusions during spermatogenesis rather than to a study of chromosome patterns. References to chromosome in these studies are only incidental and the chromosome counts of the species they investigated are not, in all cases, accurate.

A review of literatures (Table I) on the chromosomes of Diplopoda shows that so far seventeen genera have been investigated. From the record it is evident that the male is heterogametic in all species so far studied. Thus the sex mechanism is XY : XX type. The diploid chromosome number as determined are 8, 12, 14, 16, 20, 24, 25, 26 and 30. It would thus appear that the Diplopoda forms are rather a heterogenous group. The variation in the haploid chromosome number is ranging between 4 and 15. These species are also characterised by symmetrical karyotypes *i.e.*, all of them are acrocentric except two species, *Thyroglutus* sp. and *Xenobolus* sp. in which the autosomes are reported to be metacentric (Natarajan, 1959).

Chowdaiah (1967) previously has reported abnormal sex chromosome behaviour in male *Thyropygus* sp. He observed the probable co-existence of both pre-reduction and post-reduction mechanism in a few cells. However, in the present study no such mechanism was observed. The length of the chromosome varies from 2·8μ to 0·8μ (Table 2). The sex pair belongs to third category of size and during meiosis X and Y invariably form a regular bivalent. It is characteristic of the sex chromosome as a rule to segregate in the first meiotic division and to divide equationally in the second.

TABLE 1

A synopsis of the chromosome number and sex chromosome mechanism in males of different species of Diplopoda so far studied.

Number	Species	Chromosome number		sex mechanism	References
		n	2n		
1.	*Polydesmus complanatus*	4	8	?	BESSIERE, 1948
2.	*Xenobolous acuticonus*	6	12	XY	NATARAJAN, 1959
3.	*Thyroglutus* sp.	6	12	XY	do
4.	*Harpurostreptus* sp.	6	12	XY	CHOWDAIAH, 1965
5.	*Chondromorpha mammifera*	7	14	XY	do
6.	*Polyxenus* sp.	8	16	XY	SOKOLOFF, 1914
7.	*Glomeris annulata*	10	...	?	BESSIERE, 1948
8.	*Spirostreptus asthenes*	8	16	XY	CHOWDAIAH and KANAK, 1970
9.	*Ktenostreptus* sp.	10	20	XY	CHOWDAIAH, 1965
10.	*Schizophyllum sabulosum*	12	...	?	BESSIERE, 1948
11.	*Thyropygus* sp.	12	24	XY	CHOWDAIAH, 1965
12.	*Pachyiulus varius*	12 or 13	24 or 25	XO	OETTINGER, 1909
13.	*Aulacobolus* sp.	13	26	XY	CHOWDAIAH and KANAK, 1970
14.	*Phyllogonostreptus nigrolabitus*	12 or 13	25	XO	NATARAJAN, 1959
15.	*Arthrosphaera zebraica*	13	26	XY	CHOWADAIAH, 1966
16.	*Arthrosphaera* sp.	15	30	XY	do
17.	*Strongylosoma* sp.	...	24	...	do

TABLE 2

Mean length in micra and the percentage length of the haploid set of spermatogonial chromosomes of T. nigrolabitus

Serial order of autosomes	Mean Length in micra	Percentage Lengtn	Serial order of autosomes	Mean Length in micra	Percentage Length
1	2·89	13·46	8	1·31	6·10
2	2·55	11·88	9	1·10	5·13
3	2·25	10·01	10	1·06	4·93
4	2·12	9·87	11	0·89	4·14
5	2·04	9·50	X Chromosome	0·97	4·52
6	1·74	8·10	Y Chromosome	0·84	3·91
7	1·70	7·92	TOTAL	21·46	

The term type-number is often used to indicate the basic number in the ancestral form of the group, the other members having all been presumably derived from it. However, it could not be suggested for Diplopoda as the number of chromosome varies widely in different species. It is hoped that completion of the cytological analysis of a large numbr of species will afford a clearer perspective of the evolutionary history of this ancient group.

ACKNOWLEDGMENT

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STUDIES ON THE APHIDIDAE OF INDIA—XI. BIOMETRICAL STUDIES OF THE COMMON APHID, *APHIS GOSSYPII* GLOVER (APHIDIDAE, HOMOPTERA)*

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ABSTRACT

The biometry of *Aphis gossypii* Glover collected on *Tridax procumbens*, *Cocculus villosus* and *Psidium guajava* have been studied in order to determine the host preference of the aphid species.

INTRODUCTION

Aphis gossypii Glover is cosmopolitan in distribution and occurs all the year round (Behura, 1963). It is polyphagous and attacks as many as 141 different species of plants in India (Behura, 1963, 1965). The population increases in winter which is the most favourable season for the growth of aphid population and in other seasons the number falls down to the minimum. *A. gossypii* is extremely variable in size and colour even in the same population on any particular host plant. The present paper deals with biometrical studies of population of the aphid species on three selected host plants viz., *Tridax procumbens*, *Cocculus villosus* and *Psidium guajava* in order to find out the extent of biometrical variation that occurs due to change of host plant, the season remaining the same. The study is based on data available at the Post-Graduate Department of Zoology, Utkal University in the project reports and thesis of M.Sc. students of Sri B. N. Panda, Sri P. K. Das, and

*The earlier parts in the series appeared as follows : I. *Prakruti—Utkal Univ. J. Sci.*, Bhubaneswar, 5(2) : 1—16 (1968) ; II. *Ibid*, 5(2) : 63—81 (1968) ; III. *Ibid*, 6(1) : 1—6 (1969) ; IV. *Ibid*, 6(1) : 79—93 (1969) ; V. *Ibid*, 7(1) : 57—76 (1970) ; VI. *Ibid*, 8(1) : 53—64 (1973) ; VII. *J. Zool. Soc. India*, Calcutta, 24 : 161—167 (1974) ; VIII. *Prakruti—Utkal Univ., J. Sci.*, Bhubaneswar, 8(2) : 139—154 (1973); IX. *Ibid*, 8(2) : 179—183 (1973) ; X. *Proc. Nat. Acad. Sci.*, Alfahabad, 43 (B), III : 136-139 (1974).

Sri B.M. Prusty on collections of *A. gossypii* made on the host plants *C. villosus*, *P. guajava* and *T. procumbens* during the winters of 1967-68, 1969-70 and 1970-71 respectively. As far as the authors are aware, the only statistical study on *A. gossypii* published in India so far is that of Mookhopadhyay and Roychoudhury (1961) based on a preliminary analysis of dimorphism in the aphid species. This analysis is a preliminary approach to the study of the problem of host preference of the aphid species.

MATERIALS AND METHODS

Data in respect of important morphological characters of alate and apterous viviparous parthenogenetic females of *A. gossypii* collected on the three different host plants were subjected to statistical analysis. Standard error and standard deviation were calculated. At a time, the measurements of any particular morphological feature in populations on two different host plants such as, between H_1 and H_2, H_2 and H_3 and H_1 and H_3(*vide infra*) were taken into consideration and subjected to 't' test. The computed 't' values were compared with the table values of 't'. If the computed value of 't' was found to be more than the table value against N_1+N_2-2 degree of freedom at 1% probability (*vide infra*), then it was regarded as highly significant. If the difference between the two means was significant then the character having higher mean was considered as superior over the character showing lower mean. Accordingly, the significant character for each of the three sets i.e., H_1 and H_2, H_2 and H_3 and H_1 and H_3 was found out. From the significant characters the superiorly significant character was deduced by simple mathematical deductions. The host plants from which the aphids were collected and showed superiorly significant result with regard to morphological characters of the aphid species was reagarded as the most suitable host plant.

The following formulae were used for the statistical analysis:

$$S.E._{\bar{x}} = \sqrt{\frac{\Sigma(X \sim \bar{X})^2}{N(N-1)}}$$

(Standard Error of the mean)

$$t = \frac{MH_1 \sim MH_2}{s\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

Where $s^2 = \frac{S.S.\ (H_1) + S.S.\ (H_2)}{N_1 + N_2 - 2}$

and X = Individual character
$\bar{X}$ = Mean (M)
N = Number of observations
Σ = Sum
S.S. (H_1) = Corrected sum of squares for H_1
S.S.(H_2) = Corrected sum of squares for H_2
N_1+N_2-2 = Degree of freedom
N_1 = Number of readings for H_1
N_2 = Number of readings for H_2
H_1, H_2 and H_3 = Host plants ; H_1 *Tridax procumbens*, H_2 *Cocculus villosus*, H_3 *Psidium guajava*.

N_1, N_2 and N_3 = The number of readings of a particular character of *A. gossypii* taken respectively on H_1, H_2 and H_3.

DATA AND ANALYSIS OF DATA

Ratios of measurements of taxonomically important characters of *A. gossypii* on the three host plants are given in Table 1. The significantly superior characters of apterous and alate forms of *A. gossypii* in relation to the corresponding ones on the three different host plants are given in Tables 2 and 3.

Studies of biometry of alate and apterous forms of *A. gossypii* belonging to three different populations and collected on three different host plants *viz.*, *T. procumbens*, *C. villosus* and *P. guajava* show that the host plant has profound influence on the size of the different morphological characters of the aphid species and that *T. procumbens* is undoubtedly its most suitable host plant among the three plants. It is interesting to note that characters of apterae which are significant in relation to a particular host plant, are not necessarily significant for alatae taken on the same host plant. Again it was observed that certain characters develop better on a particular host plant in comparison to other host plants indicating thereby specific host-suitability for particular character(s).

If a gradation of host plants under study is made for apterae of *A. gossypii* on the basis of host suitability, it is observed that the same does not tally with that of alatae. The results stand thus :

Apterae : *Tridax procumbens* > *Cocculus villosus* > *Psidium guajava*
Alatae : *Tridax procumbens* > *Psidium guajava* > *Cocculus villosus*.

Table 1

Mean ratios of measurements of taxonomically important characters of apterous and alate viviparous parthenogenetic forms of Aphis gossypii *Glover on three different host plants*

Characters	*Tridax procumbens* (H_1)		*Cocculus villosus* (H_2)		*Psidium guajava* (H_3)	
	Apterous	Alate	Apterous	Alate	Apterous	Alate
1. Length of antennal seg. IV/ant. seg. III	0·710	0·695	0·707	0·794	0·689	0·685
2. Length of ant. seg. V/ant. seg. III	0·412	0·650	0·729	0·803	0·715	0·661
3. Length of ant. seg. VI (base)/ant. seg. III	0·412	0·364	0·433	0·475	0·484	0·425
4. Length of ant. seg. VI (flag)/ant. seg. III	0·961	0·925	1·103	1·257	1·305	1·045
5. Length of cornicle/ant. seg. III	1·276	0·743	1·253	0·921	1·115	0·760
6. Length of cauda/ant. seg. III	0·612	0·403	0·553	0·454	0·689	0·442
7. Length of antenna/length of body	0·583	0·724	1·520	0·833	1·618	0·744
8. Length of cornicle/length of cauda	2·083	1·844	0·775	2·019	0·797	1·719
9. Length of cornicle/length of body	0·176	0·134	0·226	0·160	0·188	0·131

Table 2

Superiorly significant characters of apterous viviparous parthenogenetic females of Aphis gossypii *Glover collected on* Tridax procumbens, Cocculus villosus *and* Psidium guajava *at Cuttack.*

Tridax procumbens H_1	*Cocculus villosus* H_2	*Psidium guajava* H_3
1. Length of the body	1. Length of the rostral seg. II	1. Length of the rostral seg. I
2. Breadth of the body	2. Length of the rostral seg. IV	2. Length of the rostral seg. III
3. Length of the antennal seg. II	3. Total length of the rostrum	3. Length of the coxa of mid-leg.
4. Length of the antennal seg. III	4. Length of the antennal seg. I	4. Length of tarsus I of mid-leg.
5. Total length of antenna	5. Length of antennal seg. III	
6. Length of the coxa of foreleg	6. Length of the antennal seg. V	
7. Length of trochanter of foreleg	7. Length of the antennal seg. VI (b)	
8. Length of femur of foreleg	8. Length of the antennal seg. VI (f)	
9. Length of tibia of foreleg	9. Total length of antenna	
10. Length of tarsus I of foreleg	10. Length of trochanter of foreleg	
11. Length of tarsus II of foreleg	11. Length of femur of foreleg	
12. Length of claw of foreleg	12. Length of tibia of foreleg	
13. Total length of foreleg	13. Length of coxa of hind leg	
14. Length of coxa of mid-leg	14. Length of tarsus I of hind leg	
15. Length of trochanter of mid-leg		
16. Length of femur of mid-leg		
17. Length of tibia of mid-leg		
18. Length of tarsus I of mid-leg		
19. Length of tarsus II of mid-leg		
20. Length of claw of mid-leg		

Table 2 (*Contd*)

	Tridax procumbens H_1	*Cocculus villosus* H_2	*Psidium guajava* H_3
21.	Total length of mid-leg		
22.	Length of coxa of hind leg		
23.	Length of trochanter of hind leg		
24.	Length of femur of hind leg		
25.	Length of tibia of hind leg		
26.	Length of tarsus I of hind leg		
27.	Length of tarsus II of hind leg		
28.	Length of claw of hind leg		
29.	Total length of hind leg		
30.	Length of cornicle		
31.	Breadth of cornicle at base		
32.	Breadth of cornicle at tip		
33.	Length of cauda		

Table 3

Superiorly significant characters of alate viviparous parthenogenetic females of Aphis gossypii *Glover collected on* Tridax procumbens, Cocculus villosus *and* Psidium guajava *at Cuttack*

Tridax procumbens H_1	*Cocculus villosus* H_2	*Psidium guajava* H_3
1. Length of the body	1. Length of rostral seg. II	1. Length of rostral seg. I
2. Breadth of the body	2. Length of rostral seg. IV	2. Length of rostral seg. III
3. Length of antennal seg. II	3. Length of antennal seg. V	3. Length of rostral seg. IV
4. Length of antennal seg. III	4. Length of antennal seg. VI (base)	4. Length of antennal seg. I
5. Length of antennal seg. IV	5. Length of antennal seg. VI (flag)	5. Length of antennal seg. II
6. Length of trochanter of foreleg	6. Total length of antenna	6. Length of coxa of foreleg
7. Length of femur of foreleg	7. Total length of foreleg	7. Length of trochanter of foreleg
8. Length of tibia of foreleg	8. Length of claw of hind leg	8. Length of tarsus I of foreleg
9. Length of tarsus I of foreleg	9. Length of cornicle	9. Length of tarsus II of foreleg
10. Length of tarsus II of foreleg		10. Length of claw of foreleg
11. Length of claw of foreleg		11. Total length of foreleg
12. Length of femur of mid-leg		12. Length of coxa of mid-leg
13. Length of tibia of mid-leg		13. Length of trochanter of mid-leg
14. Length of tarsus I of mid-leg		14. Length of tarsus I of mid-leg
15. Length of tarsus II of mid-leg		15. Length of tarsus II of mid-leg
16. Length of claw of mid-leg		16. Length of claw of mid-leg
17. Length of coxa of hind leg		17. Total length of mid-leg

Table 3 (*Contd.*)

Tridax procumbens H_1	*Cocculus villosus* H_2	*Psidium guajava* H_3
18. Length of trochanter of hind leg		18. Length of coxa of hind leg
19. Length of femur of hind leg		19. Length of trochanter of hind leg
20. Length of tibia of hind leg		
21. Length of tarsus II of hind leg		
22. Length of claw of hind leg		
23. Total length of hind leg		
24. Length of forewing		
25. Breadth of forewing		
26. Length of hind wing		
27. Breadth of cornicle (at base)		
28. Length of cauda		

Ratios of characters of taxonomic importance have been worked out for all the three populations of *A. gossypii* on the three different host plants and compared among themselves. It is observed that length of cornicle / length of cauda in both alatae and apterae, length of antenna/length of body in apterae show remarkable variation.

SUMMARY

Biometrical data in respect of apterous and alate viviparous parthenogenetic females of *Aphis gossypii* Glover collected on three different host plants *viz.*, *Tridax procumbens*, *Cocculus villosus* and *Psidium guajava* have been statistically analysed. Among the three host plants *T. procumbens* proved to be the most suitable for the gorwth of different morphological characters of both apterous and alate forms in comparison to *C. villosus* and *P. guajava*. Ratios of taxonomically important morphological characters have been worked out for the three populations and it is found that length of cornicle / length of cauda in both apterae and alatae, length of the antenna / length of the body in apterae show remarkable variation.

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CASTE COUNCIL OF THE BAURI OF BHUBANESWAR

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INTRODUCTION

Caste-councils are considered as an effective instrument to control the members by formulating, interpreting and enforcing the rules and regulations concerning the caste. This socio-political organization embraces the whole complex of institutions by which law and order are maintained in the community. This, on the other hand, maintains the integrity and solidarity of the group with the neighbouring communities and takes defensive action against enemies who threaten the unity, solidarity and security either from outside or from within.

The caste-council of the Bauri under reference is locally called as the "*Jātiāna Sabhā*" controlled by a number of hereditary officers called, "*Santha-Mahanta*", "*Guru-vaisnab*", *Saradār Beherā*", "*Padā/Desha Beherā*," "*Ganjāhāri*" etc. The rules and regulations of this caste-council were unwritten and the important issues relating to the caste were decided by the caste officials as per the momeory preserved in the elderly leaders and caste elders. Since 1950 onwards, the important decisions of the council have been written in the official proceedings of the assembly.

PURPOSE

This paper intends to discuss the working of the caste council of a dominant Scheduled caste of Orissa in detail and to find out changes that have occurred in it, mostly after the establishment of the new township for the State capital in the immediate neighbourhood of the Bauri settlements. Materials for this paper have been collected mostly from the verbal communication with the Bauri residing in and around Bhubaneswar. Records and official proceedings of the council have also been referred to wherever available and required.

AREA

Under the jurisdiction of the present Caste Council there are 13 Bauri hamlets (Sahi). Each ward functions as a separate entity in the

total structure of the Council. Table 1, cited below, is a summary statement about the wards and the officials representing the Caste-Council from each ward.

Table 1

List of wards and number of hereditary officials

Sl. No.	*Desha (Ward)*	*Village*	*Behera*	*Ganjhahari*
1.	Huda Sahi	Bhubaneswar	5	5
2.	Matha Sahi	do.	1	1
3.	Gate Sahi	do.	1	1
4.	Nua Sahi	do.	1	1
5.	Chemendai Sahi	do.	2	2
6.	Nalamunha Sahi	do.	2	2
7.	Nageswartangi Sahi	do.	2	2
8.	Kancha Sahi	do.	1	1
9.	Kalikadevi Sahi	do.	1	1
10.	Ramabhoi Sahi	Kapileswar	1	1
11.	Gangua Sahi	do.	3	3
12.	Haripur Patana Sahi	do.	1	1
13.	Nua Sahi	do.	1	1

As the above table shows, the number of *Behera* and *Ganjahari* differ from ward to ward according to the variation in the total population of the wards. All the Bauri wards mentioned above acted as an entity and there was no *Desha* or *Padā* organization as it exists today. In 1940, an incident occured which split the entire community into two functions, hence, *Desha* or *Padā*. One Geli, a widow, had a daughter, and due to her poverty she arranged the marriage of her daughter with an outsider working as a plough servant in the house of a local landlord. This marriage was attended to by all the members of the caste and the son-in-law, remained in the house of his father-in-law as resident son-in-law. After 2 years it was rumoured that the son-in-law of Geli is not a Bauri by caste but is a Saora (a scheduled tribe). In this context the entire Bauri community was divided into two groups. This matter was seriously debated in the *Bada Sabhā* (General meeting) of the caste and at last the *Padā Beherāas* were split up into two separate units known as "*Dasa Desha*" and "*Bāra Desha*".

STRUCTURE

The caste council of the Bauris under reference is arranged in a pyramidal structure with the "*Santha-Mahanta*" at the top and the "*Padā Beherā*" at the bottom. The Monastic head of *Bhutanāth Math* located at *Puri* (Abode of Lord Jagannath) is known as the "*Santha-Mahanta*" and acts as the adviser to the caste council. This position is hereditary and the succeeding Mahantas occupy this post one after the other. All the cases undecided in the caste council are referred to him for the final decision and all his decisions are taken to be final by the community members. A nominal fee ranging from 4 pice to 4 annas is paid to him by the caste council for giving his decision.

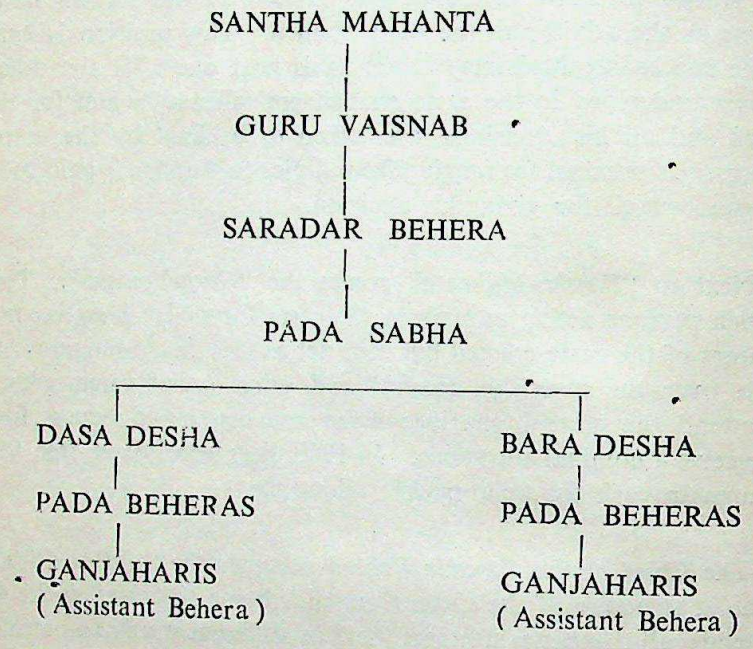
Next to "*Santha-Mahanta*" comes the "*Guru-Vaisnab*". There are two such persons acting as such in the caste Council. They act not only as officers of the caste council but also act as the Socio-religious heads to preside over the marriage, funeral and other social ceremonies. They also attend the general meetings of the caste council on request, for which they receive a nominal allowance. In 1940, they were given free food and one anna in cash for their pocket allowance.

The Chief or the *Saradār Beherā* occupies the third position in the pyramidal structure of the Caste Council. Being the chief in the Council he attends all the caste meetings held in different wards to participate in the discussion. The office of the Chief Behera is hereditary and a ceremony is held when a new man takes up office. According to the traditional custom, a new saree is tied round his head by the *Padā Beherās* and the new *Saradār* is sworn in, in the name of the caste deity. New rules and regulations are framed by him in consutation with the *Padā Beherās*.

The *Padā Beherās* come next to the *Saradār Beherā* in the pyramidal structure of the caste council. The duties and responsibilities of the *Padā Beherās* are same as that of the *Saradār Beherā*. They occupy the highest position in the *Padā Sabhā* (ward councils). It is interesting to note in this connection, that the *Padā Beherās* who act as the Socio-political head in the *Padā Sabhā* also perform menial duties, *e.g.*, duties performed by a clean caste barber in his client's house during the marriage and funeral ceremonies. For example, he carries the presents (*Bhāra*) to the bride's groom's house as the case may be. He shaves the head and beard of the clients during funeral and also on ordinary days. Whenever guests arrive to attend marriage and funeral feasts, he washes the feet of the guests in his client's houses. He prepares the marriage altar during marriage in the client's family. For these services he is paid both in cash and kind. On

the whole, the *Padā Beherās* are the socio political authorities in their respective wards. Diagram-1 illustrates the pyramidal structure of the Bauri Caste-Council.

Diagram-1



PROCEDURE FOR SUMMONING THE CASTE COUNCILS

The procedure for summoning the councils is very easy except for convening the *Bada Sabhā*. The procedure will be discussed from bottom to top *i.e.*, from *Padā Sabhā* to the *Bada Sabhā*.

Padā Sabhā

If any dispute arises in the ward or in any family it is referred to the respective *Padā Beherā* under whose jurisidiction the family is located. After receiving the complaint from a member, the *Padā Beherā* summons a caste meeting at a convenient place in the ward. No fee is paid for filing a complaint. In serious matters the *Saradār Beherā* is invited to the meeting, otherwise it is presided over by the *Padā Beherā*. After the case is tried by the *Padā Beherā* in the presence of the caste brothers, the culprit is fined and the punishment is immediately referred to the *Beherās* of the *Desha* organisations, the *Saradār Beherās* and the *Guruvaisnab* for information and necessary action. All undecided matters are referred to the *Saradar Beherā* for final decision.

The undecided and serious cases are referred to the *Saradār Beherā* who decides the matter in the presence of all the *Padā Beherās*. Formal invitations are sent to the *Beherās* by tne *Saradār Beherā* through a special messenger. Now-a-days written requests are sent to the leaders to attend the caste meetings. If the matter is decided in the meeting, the punishment is immediately communicated to all the members through the *Padā Beherās*. But the undecided cases, are referred to the General Meeting and an invitation is sent to the *Guruvaisnab* to attend the meeting. Such meetings are generally held near the caste deity.

It is important to note, that in all meetings tobacco leaf, lime, bidi were being distributed to the members present in 1940, but from 1950 prepared betel and bidi or cigarattes are being supplied by the complainant. Fines collected from the culprits are generally spent in the caste feast, usually held after these meetings. All the wards participating in the discussion contribute equally and the fines collected from the persons are also added with it to hold the feast.

PUNISHMENTS AWARDED

Punishments awarded to the culprits by the Council can broadly be divided into two categories, namely, cash fines and physical punishment, consisting of the following : Standing on one leg, holding the ear, walking round the ward or the place of the meeting carrying a jug full of water on the head, to apologize by falling flat on the ground, painting the face in black and white colours, shaving the head completely leaving seven tufts of hairs (*Sātabentiā*) on the head, etc.

Punishments are same for all, irrespective of power and position. For instance, the *Saradār Beherā* was once excommunicated by the *Guruvaisnab* and the *Padā Beherās* for having illicit connection with his unmarried sister-in-law. When the girl was found to be pregnant, the *Sarsdār Beherā* was forced to marry her. Another interesting thing happened in a meeting held in December 1966 in connection with a divorce case. The *Guruvaisnab* who performed the marriage ceremony, without the knowledge of the ward members attended this meeting. In this meeting, when the *Guruvaisnab* was found guilty by the members present, he was immediately tied to a tree by the Bauri youths present there by the orders of the *Padā Beherā* and the beads he wore as an insignia of his sacred role were also torn-off.

TYPES OF CASES DECIDED

The following types of cases are decided in the caste council. For example, commensality, inter-marriage, eating kutcha food in the house of

low caste persons, adultery, cow killing, maggot in sore, theft, land disputes, family quarrels and all other matters pertaining to the society.

Following is a list of complaints filed in the Bauri Caste Council during 1950 to 1960. Exact translations of few complaints are cited below as illustrations.

Case 1—Complaint of a member to the *Padā Beherā* for the non-co-operation of his caste brothers with him.

(Under the holy protection of goddess Kali Kapilanath).

.....That my younger brother Nisa Das requested for the attendance of our caste brothers on the occasion of his daughter's marriage. But the caste brothers refused to attend under the pretext that our son-in-law Bhagaban Bhoi was a member of our group. The caste brothers would not attend our function. The caste brothers however demanded respect from our son-in-law in our conventional manner for the above offences against our caste. We contended that if the said outsider does not belong to our caste and the fact is proved in the presence of gentlemen we would submit ourselves to any punishment awarded or pay any fine imposed...Hence it is put up for consideration.

Yours

No Name

Case—2. Complaint to the *Saradār Behera* by a *Padā Beherā* against member for doing anti-caste works.

Following works are being done forcibly without reference to the *Beherā*.

1. *Uthiary Kārya* (Maternity work) in the house of Hadu Bhoi and Agadhu Bhoi, father of Nila Bhoi.

II. The Grandmother of Babua Bhoi expired and before her death she confessed her guilt of having (*a*) taken food (*Bhakhyabhojan*) in the house of a *kācharā* (Bangle seller); and (*b*) killed a calf. The dead body of the said woman was carried without the permission of the Behera.

Sd/- **Diba Das**

Behera, Kapileswar

Case—3. The following petition based on a dispute over a plot of land, was addressed to the *Saradār Beherā.*

.....Someone had eased himself/herself on the land, which had fallen to my share and *had covered the excreta by ashes.* On seeing this, I shouted loudly asking as to who has done this mischief. Just after a day of the above incident, I went to the garden area and found some fresh excreta lying there. I therefore, shouted some abuses to the unknown miscreant. Banshidhar was sitting nearby. *He asked me using fowl languages* (Hailo hai bajāti rāndi) as to why I was abusing them and since the garden area belongs to them they are using it and will continue to use it.

The undersigned humble petitioner will remain grateful if you take up this matter and dispose it off properly.

Yours
Sd/- **Basanta**

Case-4. Complaint to the *Saradār Beherā* by a ward member based on chastity.

.....Wives of Hadu Kandi and Iswar Kandi had gone for work. At the work site the mason asked Iswar's wife, why she was looking gloomy (*Munha kāinhiki sukhi jāichhi*). Iswar's wife came to Hadu's and told her why the mason was talking like this. Hadu's wife replied that because the mason was our grand father (*Ajā*) he said so and as she herself was sleeping with him, Hadu's wife should sleep likewise. Iswar's wife reported this to her father-in-law saying that the mason was talking in this fashion. Her father-in-law said that the mason cannot be their grand father since he was not related to them at all. We the ward members and Beheras therefore, called for an explanation for all these improprieties.

Therefore, you are requested to look into the matter personally.

Sd/- **Adhikari Behera**

Case 5. Complaint on a social issue.

.....Beg to submit that, we both the parties belong to the same community and are kinsmen. When the opposite party's mother died some quarrel broke out between us. Thereafter, for the funeral of his uncle Jogi Bhoi, he took my son to Bhingarpur and insulted my son and abused him filthily ; my son had to come back without taking food there. The same night we had hot exchange of words over many things and ultimately he segregated me to perform this ceremony. Since then he entertains ill-will towards us, and to take revenge he is now creating various obstacles in the matter of my son's marriage. I therefore, pray that this case may kindly be enquired into and necessary actions taken thereon.

No Name

Case. 6. Petition of a local Brahmin against a Bauri for non-payment of share (*Sanjā*) paddy.

.....My humble prayer for consideration is that...I had given 10-11 acres of my land near Kedargouri to Arakhita Behera, son of Aparti for cultivation since last two years on *sanja* basis ...for payment to me by him...per annum. Also, during the last two years he has taken paddy worth of Rs. 30 towards repairing cost of the land (*Kādhiā*).

I maintain myself on *sevapuja*. It may kindly be considered as to how I shall maintain my family without the above income. My dues may kindly be recovered from him and delivered to me.

Sd/- **Binayak Mahapatra**

It is very difficult to narrate the decision of the Council on the above complaints, as the decisions were not written in any register or on the body of the applications. Secondly, the *Beherās* and the *Saradār Beherā* could not tell me the exact punishment given to the culprits from their memory.

According to my informants, the written complaints created a difficulty among the leaders as well as the illiterate people. An elderly Behera in an interview narrated to me in the following language :

"While deciding cases in 1940 and before, we did not require the help of others as the complaints were lodged verbally. But now we take the help of a literate man to read the applications as most of the *Beherās* are illiterate."

This on the other hand, created difficulty among the memebers. Illiterate members sought the help of the literate young men in the ward as well as in the nearby wards to write a petition for which they paid cash.

Changing Scene

A new Council called the '*Mahābhoi Samity*' was established by the youths in 1950, when partiality and misappropriation were widespread in the traditional caste council. The members did not get proper justice from the Council and the hereditary officials were bribed by the parties.

In order to establish clean administration in the caste structure, Youth Association (*Yubak Sanghas*) have been formed in all the wards, and even in the villages. These associations acted only as an appellant authority. New officers have been nominated to these secular bodies from among the youths of the caste.

In the beginning, all the hereditary leaders did not co-operate with this secular body but when these associations were supported by the caste members at large, they supported the association. All the *Padā Beherās, Saradaār Beherā* and the *Guruvaisnab* etc. now-a-days attend these meetings.

All the complaints made direct to the President of the association are forwarded by the Secretary of the Youth Associations. These Associations also deal with important issues and their decision are strictly followed in the caste. The following is an extract of an important decision taken in the Association which was strictly followed by the members.

"On the night of 18-2-1958 (Tuesday) the *Beherā Gosāins* of the 12-*Desha* and 10-*Desha* of Bhubaneswar sat in a meeting at the *goddess Chungudāi*. It was resolved in the presence of the 10-*Desha* 12-*Desha Beheras* and all the *Mahanta Gosāins*, that only the widow, the helpless poor women and also the aged old women can go out for work, *i.e.*, who are below 40 years cannot go for any work on any day and must not be seen in the market area, particularly in the evening. Those women must not be seen at the houses of anybody on any personal work in Bhubaneswar or any young woman must not be seen talking to any man of other communities. If any other *Beherā* or *Saradār Behera* violates this and acts against the above resolution he will be fined Rs. 500/- towards damages (*Kshati purana*)."

As said earlier, partiality and misapprobation of the hereditary officials in the Council helped to bring changes in the traditional structure of the Caste Council. Change was not only confined to the establishment of the *Samity* but it also changed the traditional size and functions of the traditional Council. To illustrate, Maga Behera of Mati Sahi, one of the Beheras of the 22-*Desha* joined the Caste Council of the Bauri residents of *Dumuduma*, leaving his traditional Caste Council and the *Desha* organisation. On enquiry it showed that personal quarrel of the *Beherās* with the *Saradār Beherās* forced Maga to leave the Council along with his clients. Thus, the size of the 22-Desha now has reduced to 21.

Establishment of the Youth Associations reveals the gradual decline of power of the hereditary officials to secular leaders. In this connection, the author was told that the *Santha Mahanta* of the Council who occupied a prominent position is no longer consulted. In 1966, disputes arising in the wards regarding the socio-political issues are mostly referred to the clean caste persons instead of the traditional Caste Council. This on the other hand shows transfer of power from hereditary to secular officials. The decisions of the *Padā Beherās, Sardār Beherā* and *Santha Mahanta*

are not always honoured. The punishment to the *Guruvaisnab* mentioned elsewhere in this paper proves this statement. For this, the inter-relationships among the *Beherās* also do not run well.

Punishments awarded by the Council, also, are not observed properly. Excommunication, which was considered to be a major punishment, is no longer cared for by the members. In this connection, the author was told that "match boxes are sold in the market, water is plenty in the road side water tap, and employment is abundant in New Capital. So, what is the meaning of the present excommunication ?". Therefore, a new type of leadrship is gradually coming into prominence among them. It is worth quoting Mr. Hans Negpaul, of Planning Commission, New Delhi, in this connection.

"Modern systems of transport, technology, industrialization, mechanization and western type of education during the last two to three-decades have certainly brought some changes in the rural life and the social structure is changing from a relatively closed system ordained by caste hierarchies to a relatively open system government by secular law.....but rural India is passing through a period of transition and bewilderment. The new social and economic forces generated by the large-scale development plans have shaken the social structure and are beginning to alter the old values and attitudes as well. The traditional leadership is also undergoing a change and new patterns of leadership are emerging on the scene."

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SHORT COMMUNICATIONS

STRATIGRAPHIC POSITION OF BASIC GRANULITES IN TAPANG, ORISSA

Basic granulites (orthopyroxene+clinopyroxene+plagioclase + hornblende+biotite+opaues) of Tapang (20° 5'N : 85° 35'E) constitute an important rock unit in this part of the Eastern Ghats in Orissa. They are associated with quartzites, khondalites, charnockites and granitic rocks. Usually the basic granulites lie below quartzites and occasionally are found to underlie khondalites also, in which case it has been observed that there is no quartzite below khondalite in that particular instance. The contact with either khondalite or quartzite, wherever observed, is always sharp. The detailed examination of the contact specimens shows that neither basic granulites contain in them any material of parametamorphics, nor there is any constituent of basic granulites in them.

Since structural investigations do not indicate any large scale overturning folds, the rocks should be assumed to be right side up. In this context, the fact the basic granulites invariably lie below quartzites and khondalites is very suggestive and should normally indicate that basic granulites are older than the parametamorphics. There has not been any evidence where quartzite or khondalite is overlain by basic granulite. Granitic rocks and charnockites are emplaced subsequently. Therefore within the scope of observations in this area, the basic granulites are the oldest rocks.

The hypothesis of basic granulites being the oldest should meet serious objections if they are considered as sills. Complete lack of any intrusive character of the body into the parametamorphic rocks and following of a constant horizon, *i.e.*, the base of the parametamorphites, are the two reasons for ruling out the possibility of sill. On the other hand the basic granulites could be basic sediments originally. But as has been pointed out the sharp contact with quartzite and khondalite does not explain this probability. Therefore the only other alternative that the original parent for the basic granulites was a lava seems very tenable for this area. Thus

the relative position of basic granulite in the general succession does not change. The stratigraphy is suggested as below :

Charnockites and granitic rocks
Khondalites
Quartzite
Basic granulites.

Krishnan (1935) observed that practically nothing was known about the sequence of rocks in Eastern Ghats except that khondalites were regarded as very old paraschists. In subsequent years, basic granulites have been regarded as concordant intrusive bodies into khondalites that have been taken as the oldest rocks. Recently, however, Narayanaswami (1971) observed the presence of an assemblage of metavolcanic charnockite suite overlain by khondalite suite. The present investigation supports the above contention.

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A NOTE ON WINTER COCCIDIOSIS IN CALVES

Bovine coccidiosis is a wide spread disease in all parts of the world and serious outbreaks often occur in young calves. A perusal of the available literature revealed the presence of seasonal fluctuations in the incidence of bovine coccidiosis in different parts of the world, *e.g.*, the infection reached peak in late summer and autumn in South-west of England and Northern Ireland ; autumn and Winter in U.S.A. (Soulsby, 1968), in spring and summer in Western Victoria (Reed, 1973). On the basis of regular faecal examintion of the cattle of the University Farm, Central clinic and of private owners for a period of succssive three years, it was observed that the incidence of coccidiosis reached peak in winter under the warm and humid climatic conditions of Orissa. The present study was, therefore, undertaken to determine the incidence of various *Eimeria* species, to assess the significant role of each species in contributiing the outbreak of winter coccidiosis and to study the development of the disease process in local calves.

For this investigation, faecal samples of 50 calves of either sex, between few weeks to one year old, were obtained directly from the rectum and examined for the presence of oocysts. Sugar floatation technique was adopted to recover the occysts from the faecal samples. A drop from the supernatant was examined under a compound microscope for the presence of oocysts. Cultures of faecal samples, found positive for Coccidian oocysts, were maintained in petri dishes containing 2·5% potassium dichromate solution in thin layers. The cultures were kept at room temperatures for 3—7 days for the oocyst to sporulate. The different oocysts were identified according to the descriptions given by Levine (1961) and Soulsby (1968). The approximate number of oocysts per gramme of faeces was determined using the McMaster counting techniques. To study the development of the disesae process, five heavily infected calves were kept under observations for a period of 15 days.

Out of 50 faecal samples examined for coccidian infection, as many as eight species were involved in different samples. Usually involvement of two or more types of oocysts were detected. The frequency of incidence of different *Emieria* spp. in decreasing orders were ; *E. bovis*, 64%;

E. zurnii, 24%; *E. auburnensis*, 16% ; *E. cylendrica*, 10%; *E. bukidonensis*, 6% and *E. subspherica*, 4%. Of the calves examined, 35 (*i.e.*, 70%) were found to be infected with the above eight species in local calves, which confirmed the report of Patnaik (1963). On the levels of incidence and intensity of infection, *E. bovis* was found to be the predominant species in contributing to the outbreak of winter coccidiosis in local calves. Although the infection percentage of *E. zurnii* was comparatively low, its intensity of infection was very high and this species was observed to be very often associated with clinical cocccidiosis, thereby providing its high pathogenicity (Soulsby, 1968). A maximum of five species were observed in a single faecal sample and they were identified as *E. bovis*, *E. ellipsoidalis*, *E. zurnii*, *E. auburnensis* and *E. cylendrica*. The number of oocysts per gramme of faeces ranged from 100 to over 5,000 in case of mixed infections.

Calves between 4 to 8 weeks of age were observed to be highly susceptible to coccidian infection and this finding was in general agreement with the report of Read (1973). The onset of the disease was often sudden with signs of severed diarrhoea soiling the tail and the hind quarters. Later on the heavily infected calves developed intense straibing and watery diarrohoea mixed with blood and/or mucus. Similar clinical manifestations were also reported by Davis and Bowman (1952) and Reed (1973) in natural outbreak of bovine coccidiosis. The other clinical manifestations consisted of rough hair coat, rapid dehydration, emaciation, loss of appetite and loss of bodily condition. Although the calves recovered from the disease, yet there was extreme anaemia as evinced from the paleness of the conjunctiva and gums. The anaemia was further confirmed on blood examination, which indicated a decrease in the percentage of R.B.C., haemoglobin and pack cell volume.

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DEPARTMENT OF PARASITOLOGY

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BHUBANESWAR

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A NOTE ON THE SEX DETERMINATION IN THE TASAR SILK-WORM, *ANTHERAEA PAPHIA* LINN.

Sex differentiation of the various stages in the life history of the Tasar silk moth, *Antheraea paphia* is of immense value in practical sericulture because, separation of sex prior to cocooning leads to convenience in pairing. In addition, sex-linked breeds produce only males which yield more silk, have lesser larval period resulting in lesser consumption of leaves of the host-plant and lesser loss of cocoons.

The sex differentiating characters in the different stages of *A. paphia* so far worked out at the Orissa State Sericultural Research Station, Baripada are given below.

Egg stage

In the egg stage it is difficult to determine the sex of the moth it will ultimately develop into.

Larva stage

The female larva has a pair of milky white spots on the ventral side in each of the eighth (Ishiwata's fore gland) and ninth (Ishiwata's hind gland) segments while the male larva has a small milky white body (Herold's gland) at the centre on the ventral side between the eighth and ninth segments. These markings are distinct in the 4th and 5th larval instars. The female larva is heavier in weight and bigger in size than the male larva.

Pupa stage

The female pupa has a 'X' shaped mark in between the 8th and 9th segments while the male pupa has two dots in between the 8th and 9th segments. The female pupa is heavier and bigger than that of the male.

Cocoon stage

The female cocoons are bigger in size, heavier in weight and the anterior portion of the cocoon (basal portion of the peduncle) is broad and flat while male cocoons are smaller in size, lesser in weight and the anterior portion of the cocoon is narrow. The male moth emerges from the cocoon earlier than that of the female moth. The male cocoon has more silk content than that of the female.

Moth stage

Male moth—Generally brown in colour, smaller in size, abdomen narrow. In the posterior region the 10th segment carries a hook-like structure called 'harpes', a protruded structure called 'Aedeagus'. The antenna is broad and more active than in females. The male moth flies for kilometres at a stretch.

Female moth—Generally yellow in colour. The antenna is narrow and less active than in the male, bigger in size and the abdomen is stout. An ovipositor is present at the posterior region of the body. In the 8th and 9th segments, ventrally a pair of plates carries an opening called the copulatory opening. The female moth is less active than the male. The longevity is less than that of the male.

STATE SERICULTURAL RESEARCH STATION
BARIPADA, MAYURBHANJ, ORISSA
JULY, 6 1974

B. B. RATH

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ABSTRACTS
of
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CHEMISTRY

ANNEALING STUDIES ON SOME IRRADIATED CRYSTALLINE BROMATES

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It was found by Maddock and Mohanty[1,2] that chemical radiation damage in crystalline nitrates recovers when the irradiated crystals are heated. A considerable amount of work has also been done in bromates by various workers, *e.g.*, Khare and Mohanty[3,4] Chase and Boyd [5] Andersen, Madsen, ank Olsen[6] etc. Investigations by workers other than Khare and Mohanty[3,4] did not include isothermal kinetics. The kinetics work of Khare and Mohanty [3] was confined to only potassium bromate. A detailed study has now been made on the kinetics of isothermal annealing in γ-irradiated caesium and lithium bromates. It has also been found that chemical radiation damage in bromates recovers on exposure to visible light.

Crystals (85—100 mesh) of caesium, potassium, and lithium bromates were irradiated with 60Co γ-rays to a dose of 50 Mrad at 0·83 Mrad hr^{-1}. In caesium and potassium bromates the total oxidizing fragments (bromite, hypobromite, etc.) were determined as the difference between the total non-bromate bromine and the bromide by potentiometric microtitration with standard silver nitrate with and without added excess arsenite[3]. In the case of lithium bromate, hypobromite and bromite were estimated separately and consecutively by potentiometric microtitration with standard arsenious oxide with sodium hydroxide and osmium tetraoxide added after the hypobromite end point[7].

Kinetics of isothermal annealing has been studied at different temperatures in the range 130° to 180°C in the case of caesium bromate and 110°

to 150°C in the case of lithium bromate. In lithium bromate data for annealing of bromite at different temperatures and time intervals superimpose on to a single curve in accordance with the Fletcher-Brown model[8]. The composite curve fits the following combination of a unimolecular and a bimolecular process.

$$\Phi = 0{\cdot}40[1-\exp(-t'0/.7)] + 0.45\ [1/1+(41/t')]$$

The energy of activation is 21·4 kcal mole^{-1}. From the stand point of conventional chemical kinetics, annealing is also a combination of a first order and a second order process. The activation energy of the first order process is 2·6 and that of the second order process 12·8 kcal. It is suggested that the unimolecular process corresponds to the recombination of close BrO^-_2 and O fragments and the biomolecular process to the random reaction $BrO_2 + O_2 \rightarrow BrO^-_3 + O$ followed by the rapid reaction $BrO^-_2 + O \rightarrow BrO^-_3$. It has been observed that a proportion of the fragments which would have otherwise annealed by second order kinetics change into fragments which undergo the first order process. This occurs when a BrO^- fragment close to a BrO^-_2 fragment decomposes, $BrO^- \rightarrow Br^- + O$, and the oxygen atom generated reacts with BrO^-_2 fragment by first order kinetics.

The Fletcher-Brown[8] composite curve for γ-irradiated caesium bromate fits the combination of two unimolecular and one bimolecular process given below:

$$\Phi = 0.20\ [1\text{-}\exp(-t'/0.16)] + 0{\cdot}25\ [-1\text{-}\exp(-t'/4.01)] + 0.35\ [1/1+(168/t')]$$

The activation energy is 25 kcal. Analysis according to conventional chemical kinetics shows that except for the first hr. in which it is not possible to determine the rate law because of lack of data the process is a combination of one first order and one second order reaction. The activation energy of the first order process is 3·3 and that of the second order process 10·4 kcal. Presumably, the fast unimolecular reaction which occurs within the first hr. is the decomposition of the BrO^- fragment : $BrO^- \rightarrow Br^- + O$. The slow first order and the second order reactions are the same as those postulated in the case of lithium bromate.

Results of isochronal recovery and recovery in linear tempering γ-irradiated caesium and potassium bromates over the temperature range 100° to 300° C show that thermal annealing takes place in two stages in each case. In the case of caesium bromate the stages are 100° to 210°C and 210° to 300°C and in the case of potassium bromate 100° to 190°C and 190° to 300°C.

It is observed from results on the influence of thermal prehistory of γ-irradiated potassium bromate that the annealing behaviour is dependent only on the amount of damage in the crystals and not on the time-temperature schedule to which the crystals had been subjected earlier.

Studies have been made on photoannealing of chemical radiation damage and on the dependence of photoannealing on the light frequency in γ-irradiated caesium and potassium bromates. It is found that the recovery is of the first order, and the velocity constant is 0·0005374 hr^{-1} for caesium bromate and 0·001114 hr^{-1} for pottassium bromate. The recovery in both cases is proportional to the light frequency with thresholds at 1·41 and 1·74 lv for caesium and potassium bromates respectively. The energy absorbed on exposure to light migrates through the crystal in the form of excitons which release their energy at lattice irregularities in the form of heat. When this happens at the site an atomic oxygen is trapped adjacent to a bromite ion, the oxygen acquires the activation energy for recombination with the bromite ion : $Br^-_2 + 0 \rightarrow BrO^-_3$. This view is in agreement with the fact that photoannealing is a first order process.

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CHEMISTTRY

INFLUENCE OF IRRADIATION ON THE THERMAL DECOMPOSITION OF SOME CRYSTALLINE BROMATES

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Khare and Mohanty, [1,2] and Dubey and Mohanty[3] have recently shown that the chemical damage introduced by irradiation in bromates recovers in heating the irradiated material at comparatively lower temperatures where thermal decomposition is not possible. Studies are now reported on the thermal decomposition of γ-irradiated potassium and caesium bromates, and on unirradiated barium bromate.

Analytical reagent grade potassium and caesium bromates were irradiated with Co-60 γ-rays to different doses up to 400 Mrad in the case of potassium bromate and to 50 Mrad in the case of caesium bromate. Thermal decomposition was carried out in a pyrex glass reaction vessel over various temperature ranges: potassium bromate, 385—420°C ; caesium bromate, 400—420°C; and barium bromate, 260—285°C. The reaction was followed by measuring the gas pressure evolved at different time intervals.

The decomposition proceeds without induction and the decomposition curves are sigmoid in nature. Radiation enhances the decompostion. The acceleratory and the decay stages analyse according to the Prout-Tompkins relationship[4] :

$$\log [p/(p_f - p)] = kt + c \quad \ldots \quad (1)$$

The initial gas evolution stage in potassium and caesium bromates and the linear gas evolution stage in barium bromate are represented by the linear equation.

$$p = kt + c \quad \ldots \quad (2)$$

The activation energy is not affected for low irradiation doses. Higher irradiation doses significantly alter the energy. Reasonably good compo-

site curves are obtained by multiplying time values by suitable factors. The composite curves also analyse according to the Prout-Tompkins law.[4]

The mechanisms by which γ-rays interact with matter are (*i*) the photo-electric effect, (*ii*) the Compton effect, and (*iii*) pair production, depending upon the incident γ-rays energy and the nature of the target material.[5] The Compton effect has the largest cross section for γ-rays from Co-60 ; the Compton electrons are capable of producing displacement events in potassium bromate. Mechanisms due to Varley[6] and Seitz[7] are not effective in salts containing molecular ions. However, there may be cationic displacements caused by these mechanisms.[8,9] Excitation and ionization produce chemical damage in the substance. The damage species constitute decomposition nuclei and influence the thermal decomposition rate. Cationic displacements may be responsible for the enhancement of decomposition in potassium bromate.

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BOTANY

GENETICAL INVESTIGATIONS IN RICE, *ORYZA SATIVA* L. VAR. *JAVANICA*

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A study of the behaviour of grains of varieties of the *javanica* subspecies of *Oryza sativa* L. has led to the identification of three groups termed as *tjereles* (pro-*indica*) bulus (pro-*japanica*) and gundils (intermediate). Physiological characters such as seed dormancy, photosensitivity and stiff straw as also morphological characters like uwaingoj of grains and pendent panicles have reinforced the classification.

The pattern of ontho uganin distribution in various plant parts indicates that in *javanica*, gene for pigmentation of the leaf axil is basic in contrast to *japanica* and *indica* where the gene for apiculous and the gene for leaf tip pigmentation respectively are basic.

Study of the genetic of various characters in *javanica* has indicated certain dissimilarities in linkage groups compared with those in *indica* and *japanica*. The linkage relationship between genes governing different characters in the various groups *viz*., tjerels, bulus and gundils was also demonstrated to be dissimilar. Information regarding the genetic interrelationship as useful in practical modern rice breeding programmes has been elucidated.

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BOTANY

AGRONOMY OF HIGH YIELDING VARIETIES OF RICE

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Relative performance of Taiwan *indica*, *ponlai* and local *indica* (different plant types) under varying levels of soil fertility, environmental conditions and agronomic practices conducted at the Central Rice Research Institute, Cuttack during the year 1966-68 show that growth and development of rice plant as well as the commencement of mortality of tillers were delayed by one to two weeks in *rabi* (dry) season than the *kharif* (wet) season due to linear decrease in mean daily temperature during the early vegetative phase of the crop. Irrespective of plant types the tillers possessing more than 88% of the height of the mother tiller were ear-bearing and those possessing less than 65% of the height of the mother tiller were non-bearing. The tillers possessing the height between 65% and 88% of the mother tillers were either ear-bearing or non-bearing. The boot leaf appeared at the 10th to 12th leaf stage of the mother tiller in all the varieties, irrespective of seasons. The length of the fifth internode of the dwarf *indica* was comparable to that of the third internode of the tall *indica*. The flowering was synchronyous in the tall *indica* and *ponlai* varieties whereas it was non-synchronyous in *IR*. 8, the dwarf *indica*.

The early formed tillers contributed more to grain yield/plant than the late formed ones. The contribution to grain yield/plant was in the order of secondary > primary > teritary > mother > quarternary group of tillers in tall and dwarf *indicas* while it was in the order of primary > secondary > mother > tertiary tillers in the case of *ponlai*, Chianung 242.

The number of effective tillers, tiller height, panicle length, number of fertile grains/panicle and test weight of grains of the primary, secondary and tertiary tillers were significantly and positively correlated with the grain yield/plant in all the plant types. Only in the case of *IR*.8, the dwarf *indica*, the correlation co-efficient between grain yield/plant and the height of the tertiary tillers was not significant. From the simple and multiple regression studies, it was clearly established that the contribution of the number of effective tillers, tiller height, panicle length, number of grains/panicle and test weight of grains of primary tillers was significantly the

highest follow d by the secondary tillers towards the total plant yield. But the contribution of the tertiary tillers was not significant.

The growth and yield characters of individual tillers in all the plant types were in the order of the mother > primary > secondary > tertiary > quarternary tillers.

The results of three field experiments in different seasons show that with increasing level of fertility upto 120N—60P_2O_5—60K_2O Kg/ha or 160 Kg N/ha, all the growth characters such as number of effective tillers/m^2, plant height, number of leaves/m^2, leaf area, leaf area index and dry matter production/m^2 increased. Except the individual leaf area, other growth characters showed their highest values in the closest spacing (15cm × 10cm or 20cm × 5cm) while the widest spacing (15cm × 20cm or 20cm × 15cm) had the highest leaf area in all the varieties. The tiller plants were superior to seed plants so far growth and development are concerned. The number of effective tillers and leaves/m^2 of tall and dwarf *indicas* were greater than that of *ponlai*. The plant height and invididual leaf area were in the order of tall *indica* > *ponlai* > dwarf *indica*. The leaf area index and dry matter production were in the order of tall *indica* > dwarf *indica* > *ponlai*.

Chianung 242, the *ponlai* and the widest spacing (15 cm × 30 cm) had the highest net assimilation rate (NAR) and relative growth rate (RGR) throughout the growth stages of the crop except the RGR of the reproductive phase in the widest spacing in both *Rabi* and *kharif* seasons.

The weight and volume of roots increased and length of roots decreased with increasing levels of fertility and closer spacing. The increasing level of N delayed and closer spacing advanced flowering. All the varieties had their own definite requirement of accumulated temperature for flowering. All the varieties flowered soon after the receipt of fixed accumulated temperature. It was obtained at relatively shorter period in the *kharif* season than in the *rabi* season and hence the flowering duration was relatively longer in the *rabi* season than in the *kharif* season. The panicle length number of fertile and sterile spikelets/panicle and length breadth and thickness of grain increased with increasing level of fertility and wider spacing. The tiller plants were superior to seed plants in these respects. The tall *indica* had the longest grain while the thickest and broadest grain was noticed in the *ponlai*. The number of fertile grains/panicle and thousand grain weight of the *ponlai* was greater than the tall and dwarf *indicas*.

The highest grain yield was recorded in the dwarf *indica* followed by the *ponlai* and tall *indica* whereas the straw yield was in the order of tall

indica 7 dwarf *indica* 7 *ponlai*. But the straw: grain ratio was in the order of tall *indica* 7 *ponlai* 7 dwarf *indica*. The yield of grain and straw and straw : grain ratio went on increasing with increasing levels of fertility and closer spacing. The tiller plants were also superior to seed plants as regards the yield of grain and straw. Higher combustion ratios were recorded in the dwarf *indica* and *ponlai* than the tall *indica*. Combustion ratio increased with increasing level of fertility and wider spacing.

Quadratic responses to grain yield on the different levels of fertility were recorded in Taichung (Native) 1 and Mtu. 15 in both *rabi* and *kharif* seasons and in Chianung 242 during *kharif* season.

Highest profit was obtained from the dwarf *indica* followed by the *ponlai* and tall *indica*. The profit per Kg N and per rupee of fertilizer application was the highest at 80, 120, 40 Kg N/ha levels in the case of Taichung (Native) 1, the dwarf *indica* ; Tainan-3, the *ponlai* and CB. II, the tall *indica* rspectively. Benefit/cost ratio also showed that 80 Kg N/ha level for both Taichung (Native) 1 and Tainan-3 and 40 Kg N/ha for CB. II, the tall *indica* were the most economical doses of application.

The percentage of N, P and K in the plant at successive stages of growth as well as in straw and grain at harvest was the highest level of fertility and the widest spacing in the dwarf *indica* followed by the *ponlai* and tall *indica*. But the total uptake of N and P by the crop from the soil was in the order of dwarf *indica* 7 tall *indica* 7 *ponlai* while the total uptake of K was in the order of tall *indica* Mtu. 15 or CB. II 7 dwarf *indica* Taichung (Native) 1 7 *ponlai*, Chianung-242 or Tainan-3 irrespective of seasons. Moreover the total uptake of these nutrients by the crop increased with increasing level of fertility and closer spacing. In the presence of P and K, the nitrogen content in grain and straw was always higher than in their absence.

Residual soil N, total P, extractable P, total K and exchangeable K increased in a linear fashion with increasing level of fertility and wider spacing. The residual soil fertility level after the crop harvest at 80% Kg N/ha more or less maintained values of the original status of N, P and K in the soil. The highest values of those elements were recorded in the plot of *ponlai* followed by tall and dwarf *indicas*. The percentage of organic carbon soil pH and C:N ratio went on increasing in the soil with increasing level of fertility and closer spacing. The treatments of tall *indica* had the highest organic C%, pH and C:N ratio followed by those of dwarf *indica* and *ponlai*.

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ANTHROPOLOGY

LITHIC INDUSTRIES OF SOUTH-WESTERN ORISSA

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The South-Western Orissa situated to the south of the Mahanadi, comprises districts of Bolangir, Sambalpur, Kalahandi and Phulbani. The area was explored by the author to study the evolution of lithic industrial sequence. The explorations reveal a tentative stratigraphic, climatic frame-work and a typological picture of different stone industries of the area. The pleistocene stratigraphy has been studied from the nature of sendimentations such as boulder, gravel and silt etc., and their distribution. The alternate occurrence of gravel and silt phases are suggestive of climatic change. The reconstruction of climatic cycles is rather difficult at the present, and it needs further work to establish a cycle. However, the climatic cycles have been inferred on the basis of their geological deposits and succession. The occurrence of bouldery gravel may correspond to early pleistocene but such formations are not widely distributed in the area under study except at few sections. No chronological or any other evidences have been obtained from this deposit. On the other hand, the lower silty clay and lower gravels may broadly correspond middle pleistocene. The red-silt and recent alluvium may correspond to post pleistocene to recent periods. A tentative correlation of geological sequence with the lithic industries have been attempted by the author. The lower silty clay and lower gravel which unconformably overlies the bouldery gravel, has yielded a few tools of Pebble industry. The typology of pebble industry contains features distinct from that of north Orissa Hand-axe industry. The upper clay and loose gravel probably occurs after an erosional unconformity has yielded a rich Flake-Industry characterised by a variety of Flakes with the scrapers on Flakes as the type per excellence and showing evolutionary trends. The Flakes Industry corresponds to the Middle Stone Age. (Middle Palaiothic) of North Orissa and elsewhere in India. The Upper clay (red silt of varying colours) and newer alluvium have yielded a mixture of Flake blades and microliths. Their relative age appears to be sub-recent to recent. Further analysing the industries, it is known that the occurrence of pebble industry may be a local phenomenon. The Flake Industry is rather widespread in all the reported areas of Orissa and suggest a distinct phase

of Flake tool culture in Orissa Pre-history. The Flake-blades and microliths are also widespread and their occurrence in the tribal belts of Orissa indicate a distinct trend. On this particular aspect some light on Prehistoric-primitive continum may be speculated but it needs wider examination and specific analysis. Though there has been the discovery of mammalian fossils from South Orissa, no fossil has been discovered from the area under study.

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MATHEMATICES

A FEW PROBLEMS ON FLOW OF NON-NEWTONIAN LIQUIDS WITH AND WITHOUT HEAT TRANSFER

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The thesis deals with a few problems on flow of non-Newtonian liquids with and without heat transfer. There are nine chapters in the thesis. The first chapter entitled "A few constitutive equations used in non-Newtonian Fluid Dynamics" is a general introduction for different types of non-Newtonian fluids with paticular reference to the following fluid models :

1. Second order fluids.
2. Oldroyd's elastico-viscous liquid B.
3. Reiner-Rivlin fluid when the co-efficients of the medium are the functions of the strain invariants.

In other chapters the following nine physical problems have been solved :

1. Fluctuating flow and heat transfer of a non-Newtonian fluid past a porous flat plate with time-varying suction.
2. The flow of a second order fluid between two coaxial circular cylinders due to torsional oscillation of the inner cylinder,
   (*a*) after sufficient lapse of time from the commencement of motion,
   (*b*) when motion is just engendered.
3. Laminar flow of a second order fluid between rotating porous disks,
4. Flow of elastico-viscous liquid near a stagnation point with and without suction,
5. Combined free and forced convection effects on the non-Newtonian flow through a channel,
6. Free convection flow of non-Newtonian fluids between parallel walls,

7. Free convection flow of non-Newtonian flow with and without heat sources in a circular pipe,
8. Idealized Plane Slider Bearing with a non-Newtonian lubricant.

The flow phenomena have been characterised by a member of parameters and the effects of these parameters on the flow characteristics have been studied by several graphs and tables.

The following methods have been studied to solve the fluid dynamical equations :

1. Runge-Kutta numerical integration method,
2. Extremal point collocation method,
3. Iteration method
4. Perturbation method,
5. Successive approximation method,
6. Simpson's 3/8th rule for evaluation for integrals.

Exact solutions of some problems have also been obtained.

Problems on steady and unsteady motions of the non-Newtonian liquids have been solved. In one of the problems Laplace transform technique has been used. Heat transfer in non-Newtonian fluids has been the subject of discussion of some chapters. Numerical integrations and calculations have been made by IBM 1130 digital electronic computer installed at the Utkal Universiry.

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MATHEMATICS

A FEW PROBLEMS ON FLOW OF ELASTICO-VISCOUS LIQUIDS

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The thesis deals with ten boundary-value prolems on flow of elastico-viscous liquids. The following types of problems have been discussed :

1. Fluctuating flow and heat transfer with time varying suction,
2. Quasi-steady and unsteady flows between Oscillating Cylinders,
3. Flow between rotating porous disks,
4. Flow past a porous cylinder and flow in the annulus of two porous cylinders, and
5. Free convection and combined free and forced convection flows through different channels.

Constitutive equations for the elastico-viscous liquids as proposed by Oldroyd, Walters, Coleman and Noll, and Rivlin-Ericksen have been used in the problems. An exact solution is obtained if possible, otherwise when not possible some hypothesis concerning the magnitude of parameters is made to enable integration by numerical methods. Numerical work involved in the thesis have been done by the IBM 1130 digital computer, installed at Utkal University. The following numerical methods have been used in the thesis :

(*i*) Runge-Kutta method of numerical integration,
(*ii*) Interation technique and
(*iii*) Perturbation technique.

Discussions on the velocity field, skin friction and in some problems on heat transfer have been made. Some important and new results have been obtained which are consistent with the physically motivated expectations. It is observed that elastic elements in the liquid has a tendency to increase the velocity at a point and this change is further influenced by suction or injection of liquid at the wall. Similar conclusions in case of skin-friction, pressure field and heat transfer have also been obtained. It is noted that in case of flow between two oscillating cylinders the effect of elasticity is more pronounced in case of large oscillation than in the case of small oscillation.

NEWS AND NOTES

The titles of thesis approved for the degree of Ph.D. of the Utkal University during 1972 together with the names of the authors are given below.

SHRI NIRANJAN TRIPATHY—On Huusdorff means and their applications to Fourier series. (Mathematics).

SHRI JAISHANKAR DUBE—Studies on some irradiated bromates. (Chemistry).

SHRI RABINDRANATH NANDA—Studies on mechanism of substitution action—Acid and base hyolrolysis of some Octa Hydral Cobalt (III) Complexes". (Chemistry).

SHRI SARAT CHANDRA PANDA—Agronomy of high yielding varieties of Rice. (Botany).

SHRI SARAT CHANDRA MISHRA—A new model for liquid state (Physics)

SHRI M. G. K. MURTY—Studies on photoperiodism and vernalisation in Rice. (Botany).

SHRI U. PRASADA RAO—Studies on photoperiodism and vernalisation in Rice—*Oriza sativa* L. var *javnica* (Botany).

SHRI BISHNU PRASAD ACHARYA—A few problems on flow of ilastico-viscous liquids. (Mathematics).

SHRI CHITARANJAN DAS—Kinetic studies of chemical reactions. (Chemistry).

SHRI PRAKAS KUMAR MOHAPATRA—Influence of structural changes on reaction rate, absorption and chromatogrophic behaviour. (Chemistry).

SHRI NIRANJAN MOHANTY—Structure spectra and structural phermacological activity relationship. (Chemistry).

SHRI GAURANGA CHARAN DAS—A few problems on flow of non-Newtonian liquids, with and without heat transfer. (Mathematics).

SHRI S. C. PRASAD—Genetical studies in cultivated Rices. (Botany).

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Date ; November, 1975

Sd/- **B. K. Behura**

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